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An Ice-Breaking Train Ferry for Quebec

In the accompanying figures are shown the steamer "Leonard" just completed at Birkenhead, England, for the special service of transporting standard passenger railway trains or freight cars across the St. Lawrence River between Quebec and Levis at all seasons of the year. The weight of train to be carried is 1285 tons. The ferry has been designed so that the time taken in running the train upon the ferry, traversing the river (a distance of 2½ miles), and landing and coupling up the train will not occupy more than three-quarters of an hour. The particular features of interest in the design are: (1) the car deck which is raised or lowered through 18 ft., according to the stage of the tide; (2) the attachment of landing bridges to the ferry instead of to the shore houses; (3) the joints between bridges and car deck. The vessel is of the twin-screw type with a third ice-breaking propeller at the forward end. The principal dimensions are as follows:

Length overall	326 ft.
Breadth molded	65 ft.
Breadth over fenders	66 ft. 9½ in.
Depth molded	23 ft.
Mean draft	15 ft.
Speed (statute miles per hour)	15
I.hp., main engines	3200
I.hp., engines for ice propeller	420

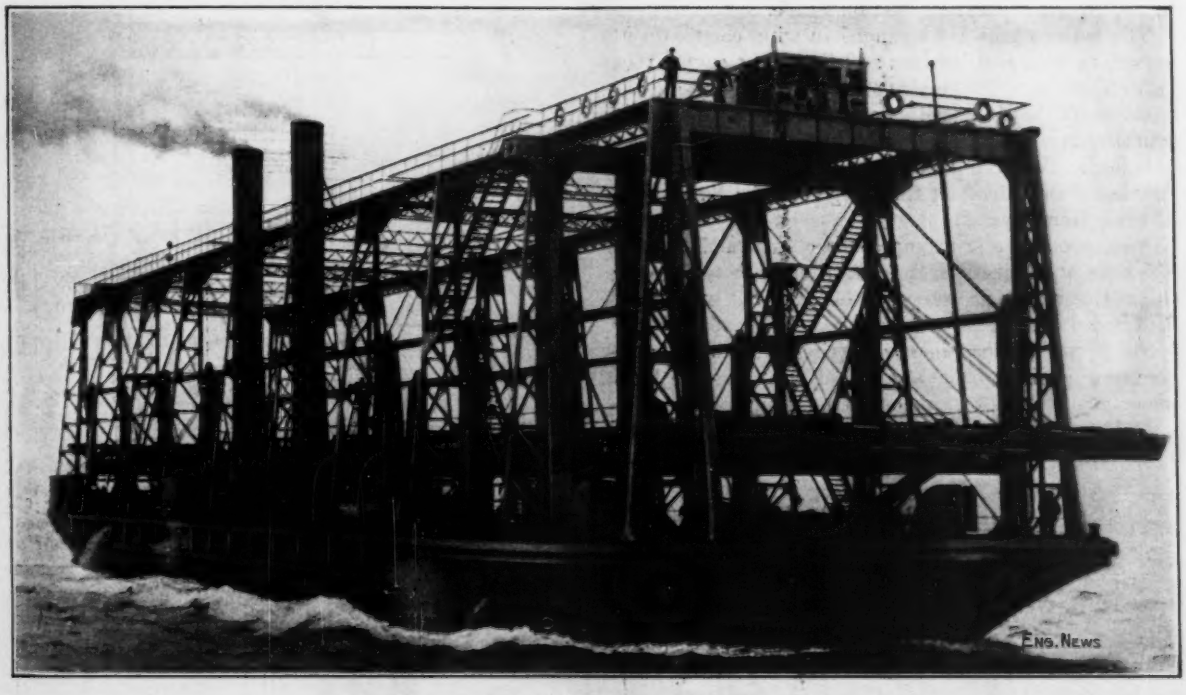

FIG. 1. QUEBEC CAR FERRY "LEONARD"

The tidal deck is arranged above the main deck of the vessel and has 10 transverse girders, each end of which rests on a large nut which works up and down on a vertical screw, giving the deck the necessary range of action to suit the various conditions of tide. Three 272-ft. lengths of track are fitted on the tidal deck, each supported on lattice girders. The deck-lifting screws are hung from ball bearings supported on strong columns. These columns are stayed by lattice buttresses against fore-and-aft and transverse thrusts, while below the main deck a strongbraced strut is built, in way of each column, to distribute the load to the keel of the ship. The main deck and hull are strengthened by additional intercostals, etc., to insure sufficient strength to resist the stresses induced by the heavy loads on the tidal deck. The braced columns below the main deck also serve to carry the worm gearing for the deck-lifting screws.

At each end of the tidal deck, an adjustable hinged gangway is suspended by means of treble purchases from struts fixed on the deck. These gangways are arranged, with ball-and-socket joints at the ends of each of the girders carrying the rails, to allow for any heel of ship or change of trim which takes place while loading or unloading the ferry. A special motor controls each gangway.

Above the highest position of coaches on the tidal deck

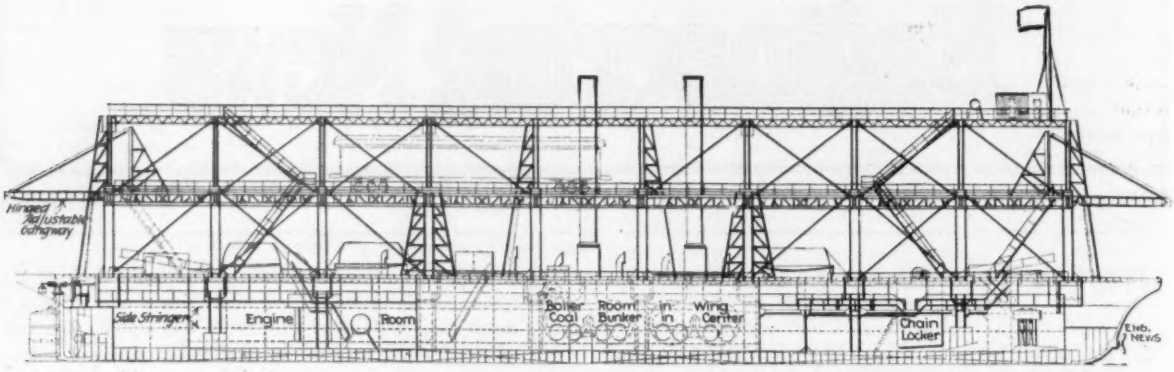

FIG. 2. LONGITUDINAL ELEVATION OF QUEBEC CAR FERRY "LEONARD"

a promenade is arranged all round the vessel with a bridge platform, at the forward end, carrying a pilot house and chart room. The promenade and bridge are carried on lattice girders supported by the buttresses. Special arrangements are made to prevent any stress which would result from the bending moment on the hull being taken by the girders supporting the promenade.

The boiler rooms are arranged in wing compartments amidships with coal bunkers and tidal deck engine room between them. The main propelling engines are situated abaft the boiler rooms and the engines for the ice propeller are placed in the hold just abaft the fore-peak bulkhead. A special feed-water tank is built in the double bottom extending from bilge to bilge for a length of three frame spaces.

Accommodation is arranged for officers and crew on a flat below the main deck forward on both sides of the ship. Everything necessary for full day and night crews is provided.

The propelling machinery comprises two sets of triple-expansion engines. The shafts and propellers are made strong enough to withstand any stresses imposed by striking solid ice. The propellers are of nickel steel. The forward (ice) propeller engine is compounded. This pro-

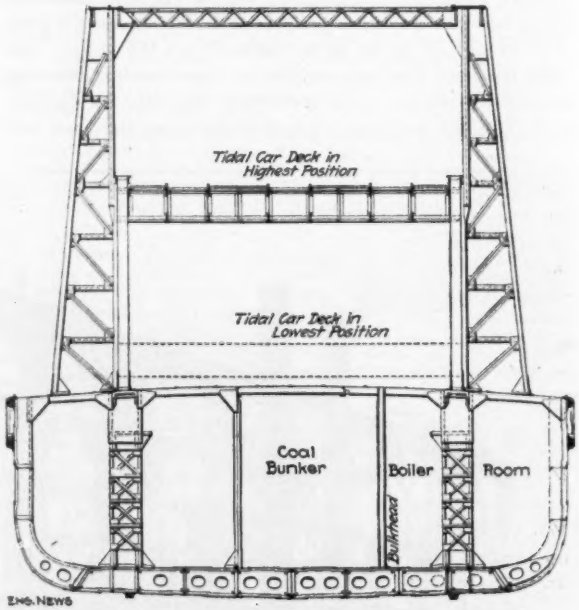

FIG. 3. MIDSHIP SECTION OF FERRY "LEONARD"

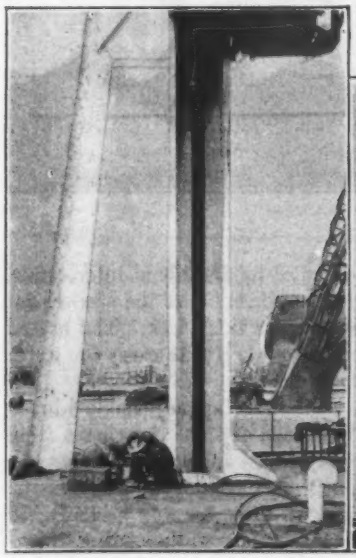

FIG. 4. LIFT SCREW AND NUT UNDER TRAIN-DECK GIRDER

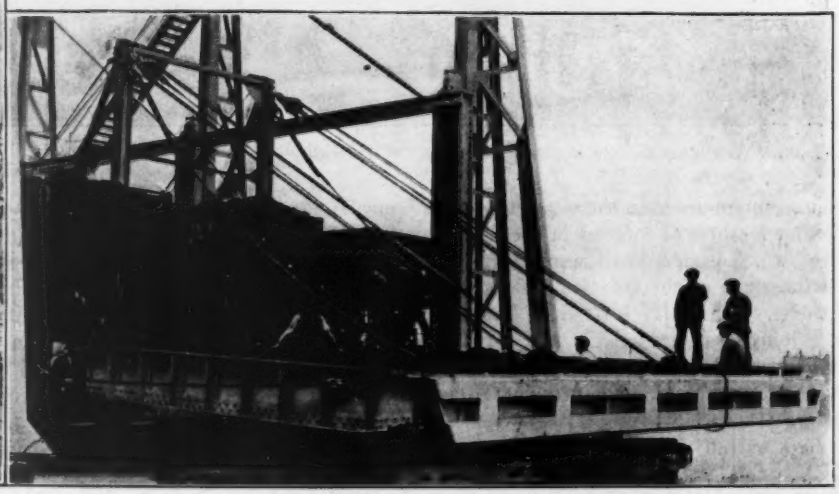

FIG. 5. TRACK GANGWAY OF TRAIN DECK; CAR FERRY "LEONARD"

peller runs idle in summer. The deck-lifting engine is a heavy high-pressure type driving a shaft athwartship through double helical spur gears. At each end of this second shaft, miter gears engage a fore-and-aft shaft on either side of the ship. These long shafts in turn work the deck-lifting screws by worm-gear connections. There is interposed between wheel and screw, however, a loose forged sleeve with sliding key. The lifting nuts in which the screws work are of heavy gunmetal, fitted into the train-deck structure.

The steamer is electric lighted. There is an electric winch with two winding drums fitted between girders of the tidal deck for hauling the carriages on or off the ship. Two powerful steam windlasses, one on each side of the ship, are fitted with slip drums for mooring.

This ferry was built to the order of the Commissioners of the Transcontinental Ry. of Canada, by Cammell Laird & Co., of Birkenhead. These details are presented by courtesy of the American agents, John Reid & Co., New York City.

The New York Rapid Transit Railway Extensions

By F. Lavis*

SYNOPSIS—The greatest engineering work in the world, measured by the amount of expenditure involved, is the extension of the rapid transit railway system of New York City. More engineers are now working on this great enterprise than on any other single work anywhere. The work is of interest not only in connection with the development of a vast transportation system; but because the tasks of construction involved are instructive to engineers engaged in a great variety of work. In order to present adequately the important features of this work for the benefit of the engineering profession, we have arranged with Fred Lavis, one of the highest authorities on tunnel construction in this country, to make a careful study of the entire work. Mr. Lavis has given much time to this task and has had the hearty coöperation of the members of the engineering staff of the Public Service Commission, whose courtesies and aid are freely acknowledged. The first of Mr. Lavis's articles is printed below and will be followed in succeeding issues with additional articles, each dealing with some special feature of this great work.

I--History and Extent

Extensions to the existing systems of rapid transit in the City of New York have been planned which will involve an estimated expenditure of $366,000,000. The construction of these lines is now well under way and is being rapidly pushed forward at a rate which, it is hoped, will insure their completion by the end of the year 1917. The length of new line is altogether 110 miles, comprising 325 miles of single main-line track. These additions will make the total length of the completed system of rapid-transit railways in the city 230 miles, with 621 miles of single main-line track. The mileage of main-line track will thus be approximately doubled, though it is expected that the capacity for handling passengers will be increased threefold or fourfold.

The magnitude of this work may be at least partly realized by comparison of its cost with that of the Panama Canal, which, including the $50,000,000 paid to the French, is to cost about $375,000,000. This vast enterprise in the City of New York is progressing literally under the feet of its five million inhabitants and the other several millions of the adjacent territory whose business brings them frequently to the city, with hardly any notice or disturbance of the regular routine of business.

The cost is to be borne in approximately the following proportions partly by the city and partly by the two operating companies which will divide the territory between them.

City of New York	$200,000,000
Interborough Rapid Transit Co.	105,000,000
New York Municipal Railway Corporation	61,000,000

The first of these two operating companies, The Interborough Rapid Transit Co., generally spoken of as "The Interborough," operates the present subway which traverses the length of Manhattan Island, reaching into the Borough of Bronx at one end and a short distance into Brooklyn at the other. It also operates the four lines of elevated railway in Manhattan and the Bronx, as well as the surface lines in those boroughs. The so called Steinway or Belmont Tunnel, running from 42nd St., New York, under the East River to Long Island City, was built about five years ago by interests closely associated with the Interborough but has never yet been utilized. It is now, however, to be finished, equipped and operated by that company, in conjunction with the other lines of its system.

The New York Municipal Railway Corporation is a company formed by the Brooklyn Rapid Transit Co. to finance and operate that part of this new system of railways which falls to its share. The Brooklyn Rapid Transit Co. is familiarly known as the "B. R. T." and both it and the New York Municipal Railway Corporation will be generally so referred to hereafter. It controls all the elevated and surface lines in Brooklyn including those which reach the famous ocean summer resort at Coney Island.

Heretofore, the operations of these two systems, the Interborough and B. R. T., have been almost exclusively confined to territories divided by the East River, the former to Manhattan and the Bronx on its west side, and the latter to Brooklyn and the Borough of Queens on the other side.

By the new arrangement, the B. R. T. gains an entrance into Manhattan by a new tunnel from the business center of Brooklyn to the lower end of New York, thence via Broadway and 7th Ave. through the center of the business and amusement districts to 59th St. Thence it turns eastward and crosses the East River on the Queensborough

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Bridge to a connection with the proposed lines to Astoria and Flushing. It also reaches lower New York by a series of underground loops connecting the three lower East River bridges and the new tunnel just referred to, which will permit also continuous circulation of its trains instead of bringing them in as at present to stub-end terminals at the New York ends of the bridges.

The Interborough, besides a new north and south line in Manhattan, will reach the Borough of Queens and will have two lines to Astoria and Flushing from 42nd St., via the Steinway Tunnel. Its present line to Brooklyn is to be extended by two branches, each to a point some five or six miles beyond its present terminus at Atlantic Ave. into the residential section of that borough.

The Borough of Queens, comprising Long Island City, Astoria, Jamaica, Flushing, etc., which up to the present, has never been served by any so called Rapid Transit Lines, will now have the two elevated lines referred to which are to be operated jointly by the two companies, linked up to both the Queensborough Bridge, the Steinway Tunnel and the 2nd Ave. elevated, and thus connecting directly with all lines in Manhattan and other boroughs.

It is of some interest perhaps to note that part of this route in Queens through Roosevelt Ave., is through

FIG. 1. ROUTE OF AN ELEVATED RAILWAY THROUGH A CABBAGE FARM IN QUEENS BOROUGH

a street not yet constructed and marked on the ground only by monuments, being now actually used for market garden purposes, as may be seen by the accompanying photographs, Figs. 1 and 2, which were taken looking along the center line of the street.

The Borough of Richmond (Staten Island) is eventually to be connected with the B. R. T. system by a tunnel under the "Narrows," the main channel connecting the outer bay with New York Harbor. This, however, does not form part of the present definitely decided-on scheme of construction.

As part of its system of records the Commission has had many hundreds of photographs taken, showing in detail the character of the streets and of each building adjacent to or near the proposed route, which might be expected to be affected in any way by the construction. This series of photographs is not only of great value for reference in case of dispute or claim for damages, which might be due to the work in hand, but forms a unique and interesting historical record of the appearance of the city at this time.

RECENT HISTORY

The adoption of the present scheme and the consummation of the contracts under which the work is now being carried out is the result of negotiations which have been carried on continuously almost ever since the completion of the present subway in 1904.

Almost as soon as operation of that line was started it was seen that the profits from operation were going to be much greater than had been expected. The public lost sight of the fact that when the contracts had been first proposed it was with considerable difficulty that anyone had been induced to accept them, and there was a great outcry, especially by the sensational newspapers, against the so called monopoly of the Interborough, and the alleged one-sided bargain with the city, and the demand arose that any future subways be operated as well as owned by the city.

Various forms of contract were therefore proposed, but none of them which required the use of private capital for construction was acceptable to bidders (see ENG. NEWS, Mar. 10, 1910, p. 288 for a discussion of the so called Triborough route). Finally it was determined to start to build certain sections with the City's money, and contracts were let for the construction of part of the Fourth Ave. subway in Brooklyn, and the Centre St. loop in Manhattan, but no arrangement was made for their operation, nor was any made until the final agreement arrived at between the Public Service Commission, the City and the two operating Companies on Mar. 19, 1913.

The Public Service Commission, which succeeded the old Rapid Transit Commission, was appointed and took office in July, 1907. A new city administration under Mayor Gaynor, and including among its members Messrs. Mitchel (now Mayor), Prendergast and McAneny, came into office Jan. 1, 1910.

The bids for the Triborough were called for in October of that year. As noted there were no bids for construction by private capital, but numerous bids were received for construction alone with city funds. The awards for this latter were, however, held up for various reasons in spite of strenuous protests from that section of the press and public which allowed the large profits of the Interborough and the alleged monopoly of this latter to obscure their judgment as to the best interests of the city and the traveling public, which many competent authorities considered were not met by the proposed scheme for the Triborough route.

FIG. 2. A STREET IN QUEENS BOROUGH ON WHICH AN ELEVATED RAILWAY WILL RUN

The objections to the Triborough were principally because it was proposed to build the lines without any arrangement for their operation, because it was felt that the new lines should be linked up to and form a part of the present system (the Triborough as laid out would not have permitted transfer except on payment of an extra fare), because the route was not considered well laid out, and because it was inadequate to meet the growing needs of the city and to properly provide for all the boroughs, and, above all, because at the time the amount of city money available for railway construction

was very limited (not more than 60 to 70 million dollars).

From the beginning, Mayor Gaynor's administration, through the Board of Estimate (the approval of which is required on all expenditures of the city's money) adopted an attitude of coöperation with the Public Service Commission, and the present contracts are the result of nearly three years of very hard work and the most persistent, patient and diplomatic negotiation between these bodies and the companies which have now finally undertaken the operation. It was necessary that the city's credit be strengthened and its borrowing capacity be enlarged, and this in itself was no small part of the task.

During all this period, certain sections of the public press were very bitter in urging their own views, and there were many committees of citizens, public meetings, etc. At one time the Interborough entirely withdrew

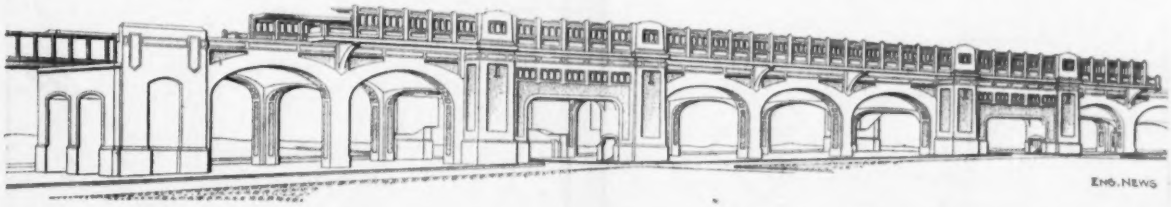


FIG. 3. DESIGN FOR ORNAMENTAL REINFORCED-CONCRETE VIADUCT ON QUEENS BOULEVARD

and everything was to be given to the B. R. T. The delay was well nigh intolerable owing to the congested and crowded condition of the present lines of transport; but it is felt now that the delay has been more than justified by the comprehensiveness of the scheme evolved, the consolidation of the lines into two large systems, either of which can be traversed throughout its length for a single fare, and the conclusion of equitable contracts by which not only will the city own the lines free of cost at the end of 49 years, but will have shared in such profits as there may be beyond a certain stated amount.

It may not be out of place to emphasize the advantage to the city from the perpetuation of the virtual monopoly of these two companies under fair and efficient regulation. The public is not only allowed a ride for a single five-cent fare over the lines of a complete system reaching almost to every part of the City of Greater New York, but the city shares in such profits as there may be from the consolidation of the management and its own contribution of credit in obtaining the greater part of the money at low rates of interest. A most important consideration is also that which provides complete arrangements for the operation of all routes in advance of design and construction, so that these latter can proceed with an intelligent conception of the operating requirements.

CHARACTER OF THE LINES

The 325 miles of new lines already decided on will be built underground in the more thickly populated sections of Manhattan and Brooklyn and elevated in the outlying districts. The subway will embrace various types of structures, both for two, three and four tracks, the latter in some cases all at the same level; in others as a double-deck structure, each level having two tracks. There are to be subaqueous tunnels under the rivers, some sunk from the surface by methods similar to those developed at the Detroit tunnel, and others probably to be driven by the shield method. The elevated will be mostly a steel structure of the familiar type, though of modern construction, but in some cases where parkways or boulevards are crossed or traversed it is being built of reinforced concrete with special attention to artistic architectural design, as illustrated in Fig. 3.

IMPROVEMENTS IN DESIGN

On all the new lines a special effort will be made to locate all the stations on tangents so as to avoid the inconvenience and possibility of danger from the space between the car and the platform on curves, which occurs at some places on the existing subway lines. An endeavor has also been made in so designing the structure at the junctions and connections of main lines and branches, etc., to avoid grade crossings of the various tracks. With the abnormal density of traffic during the rush hours this is very desirable, as the slightest delay at any one point may be, and generally is, reflected over the whole system. Footpaths at the sides of the tunnels at the level of the car platforms, similar to those built in the Pennsylvania R.R.'s New York tunnels, are to be constructed so as to provide a walk for passengers in case a train should meet with an accident and be stalled.

The new subway will be divided by partitions so as to separate the trains going in different directions, with the expectation of thereby so improving the ventilation by utilizing the piston-like action of the trains to change the air, that the accumulation of excessive heat so noticeable in the summer in the present subway may be avoided.

In furtherance of this also, waterproofing will be omitted when it is possible to do so, as it is thought that the practical inclosure of the existing subway in a waterproof envelope materially helps to prevent the diffusion of the generated heat through the walls of the structure. As is well known, locally at least, this accumulation of heat in the subway in the summer time, due to the heating of the motors, the friction of brakeshoes on wheels, the wheels on the tracks, etc., has made traveling very uncomfortable at times, the installation of expensive ventilating apparatus having only partially alleviated the trouble. In the present subway there are no division walls between the tracks, and while the trains stir up the air in passing, they do not change it very much, and not nearly to the extent so noticeable in all the single-track tube tunnels already built under the waters of New York Harbor and on all the lines of the Hudson & Manhattan Co.

Another point of interest is the provision of or for three tracks on the lines in the outlying districts where the density of travel does not require four tracks for

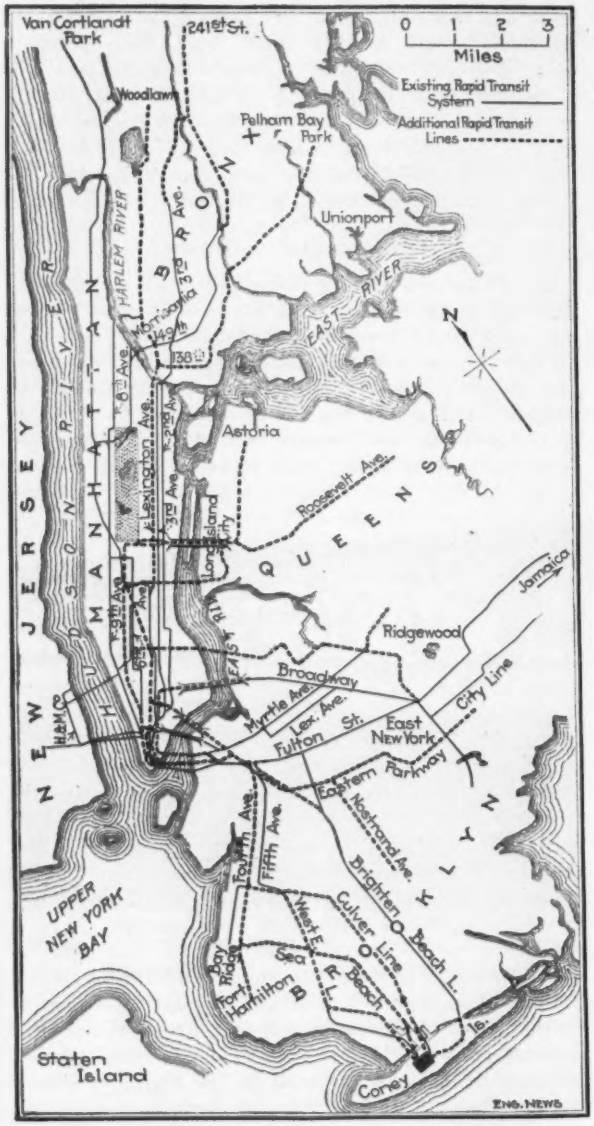


FIG. 4. THE OLDER NEW YORK RAPID TRANSIT SYSTEM AND THE NEW LINES NOW UNDER CONSTRUCTION AND PLANNED

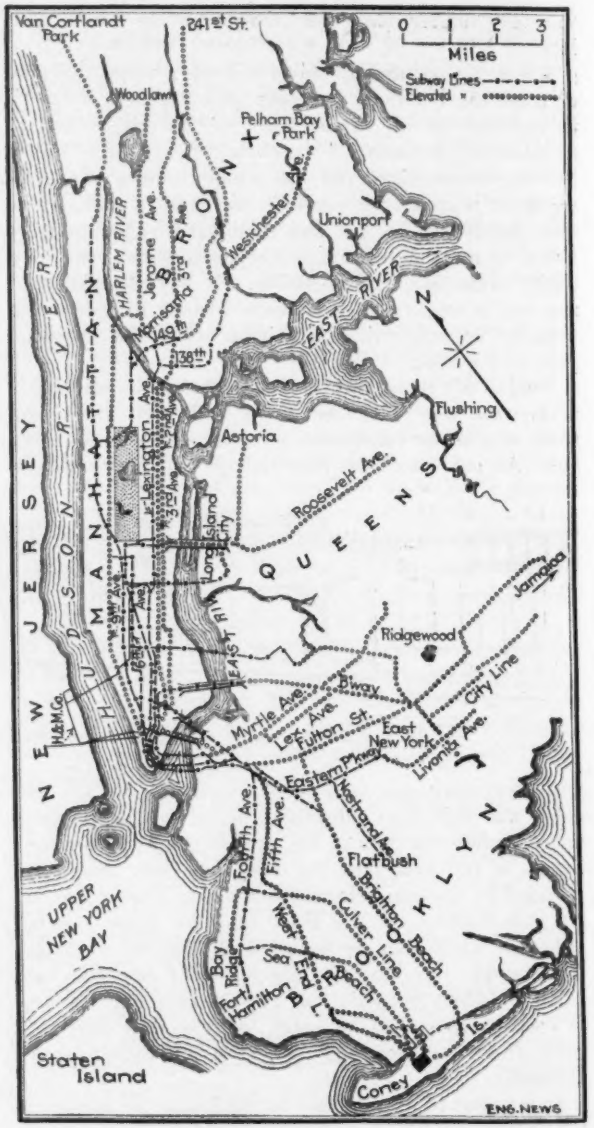


FIG. 5. SUBWAY LINES AND ELEVATED LINES IN THE COMPLETED RAPID TRANSIT SYSTEM

continuous express service. This allows express service one way during the rush hours.

EXISTING LINES

The principal feature of the rapid transit lines now in operation in Manhattan are the four elevated lines running north and south through Second, Third, Sixth and Ninth Aves., the principal parts of which were built between 1870 and 1880, and the present subway, built between 1900 and 1904.* In Brooklyn the existing elevated lines, which were built soon after those in Manhattan, radiate from the old Brooklyn Bridge, one group westerly toward Jamaica and the other toward Coney Island. Some of these last-mentioned lines, after reaching a point some five or six miles from the bridge, drop to the surface and remain there for the rest of the way to Coney Island, and all these are to be elevated (or depressed in open cuttings), and are shown on the map as new elevated lines of the B. R. T., although through trains from the bridge to Coney Island are operated over them now.

TRAFFIC

Almost ever since the elevated lines were first put into operation, it has been notorious that the congestion and crowding of the transportation lines of New York has been unequaled on any other transportation system in the world. The opening of the present subway in 1904, although it had then a capacity of 400,000 passengers per day, afforded little relief. By the lengthening of the express platforms to accommodate 10 instead of eight cars, the installation of the most modern and approved types of automatic, block signals, brakes, car

*A history of the rapid transit situation up to that date and a full description of the construction features of the original subway was published in a series of articles in "Engineering News," Vol. XLVII, Jan. to June, 1902, while a description of the proposed Triborough Route and further notes to date will be found in the "Engineering News" of March 10, 1910, p. 288.

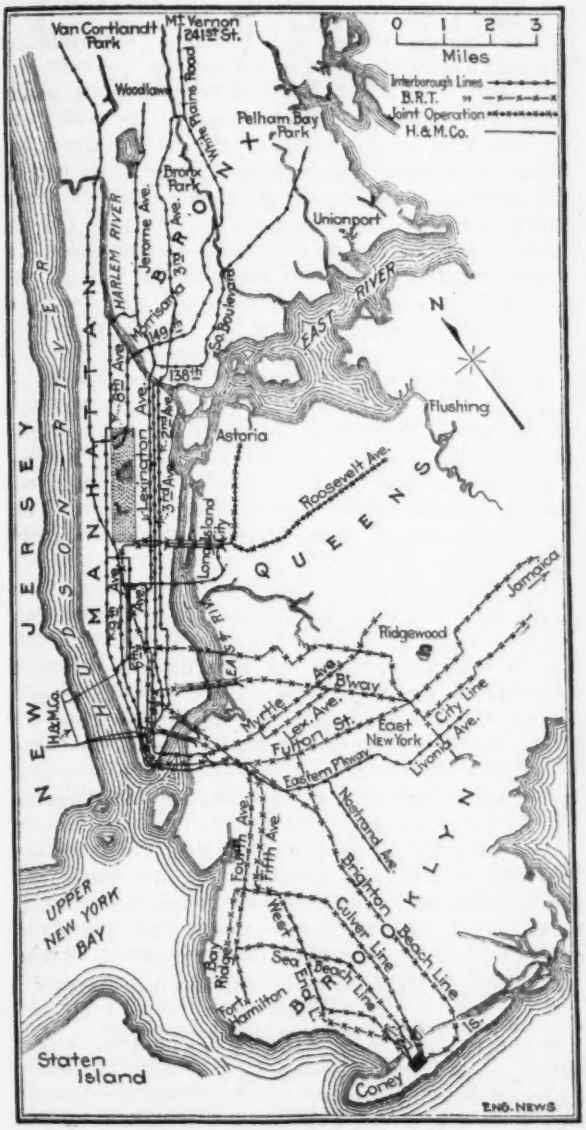


FIG. 6. THE SYSTEMS OF THE TWO OPERATING COMPANIES, THE INTERBOROUGH AND THE BROOKLYN RAPID TRANSIT

and air-line couplings, center side doors, etc., its capacity was increased so that 1,250,000 passengers can be and have been handled in 24 hours, but the crowding during the rush hours is as bad as ever on all lines.

The following figures, condensed from a table given in the last report of the Public Service Commission, with the addition of the figures for 1913, show the great and greatly increasing amount of travel, and justify the attempt to meet the requirements by the system now proposed, enormous though its cost will be:

NUMBER OF FARES COLLECTED (MILLIONS)

	Manhattan and Bronx					
	Subway	Elev.	Surface	Brooklyn All lines	Queens Surface	Total
1898.....	...	184	321	221	9	735
1903.....	...	246	427	304	16	993
1908.....	200	202	411	419	30	1342
1913.....	327	307	494	484	47	1659

(Note—In 1905, its first year of operation, the Subway carried 75,000,000 passengers. In 1914 it carried 340,400,000 passengers.)

Ever since the opening of the present subway in 1904, plans for extensions have been under consideration, first by the old Rapid Transit Commission and since then by its successor, the Public Service Commission for the First District of New York, but for the reasons already given there were various delays until the present comprehensive scheme of routes was developed to give so far as possible and, as may be seen by the maps, fair and equitable service to all parts of the greater city. There had been for some time a feeling that Manhattan had been unduly favored at the expense of the other boroughs, and while this to some extent is reasonable, both that it had, and that it should be, there can be little fault found with the scheme now laid out.

The routes of the various extensions and their character are shown on the maps, Figs. 4, 5 and 6, but for the benefit of those not entirely familiar with the situation it may be well to briefly enumerate their salient features and some of the details of the scheme.

NEW LINES

THE INTERBOROUGH—In Manhattan the Second, Third and Ninth elevated lines will complete the installation of third tracks from the down-town business section to above 125th St., thus enabling express trains to be run down-town in the morning and up-town at night.

The present subway will be divided at 42d St., the lower part being connected with the new Lexington Ave. subway, giving a four-track line all the way up the East Side, splitting into two three-track branches in the Bronx after it crosses under the Harlem River; the upper part will be connected to the new Seventh Ave.-Varick St. line, thus giving a through route up and down the West Side, and placing the Pennsylvania Terminal at 33d St. on a main line of the Rapid Transit system. The present West Farms branch of this line in the Bronx will be extended some five miles farther to the Mount Vernon line at the northerly boundary of the city.

The Brooklyn end of the present subway will be extended from Atlantic Ave. by two branches via Flatbush Ave. and Eastern Parkway into the residential sections of Brooklyn.

The part of the present subway on 42d St. between the Grand Central Station and Times Square will be operated by a shuttle service between the main lines on the East and West Sides.

The Steinway tunnel will be extended back to Times Square and forward to the east end of the Queensborough Bridge, where it will connect with the two lines to Astoria and Flushing, over which both systems are to have trackage rights. The Second Ave. elevated will be connected to the Queensborough Bridge and so to these same two lines.

There will be certain other small extensions and connections to allow the proper linking up of the various lines and permit desirable or convenient combinations in the operation of trains, all of which are shown on the maps.

The Interborough will thus have, besides its four elevated lines, four double- or three-track branches in the Bronx leading to two main trunk lines (four-track) throughout the length of Manhattan on Fourth and Seventh Aves. to two tunnel routes under the East River, joining under Fulton St., the main business street of Brooklyn, and then spreading out again into two branches into the residential section of that borough. The distance from the upper end of the Bronx to the

ends of the lines in Brooklyn is about 26 miles. From the center of this system there will be the offshoot at 42nd St. via the Steinway tunnels to the lines in the Borough of Queens to Astoria and Flushing.

THE BROOKLYN RAPID TRANSIT—Besides certain extensions of various lines in Brooklyn and the construction of the elevated structures in South Brooklyn on the Coney Island lines, as already referred to, the main features of the contract of this company with the city are those which provide for its entrance into New York and the linking up of the four bridges across the East River into lines of through travel instead of establishing terminals at their ends. There is one important new line in Brooklyn, the Fourth Ave. subway, which was started some five years ago, a considerable part of which is now nearly completed; this route extends from the Manhattan Bridge through Fourth Ave. to Fort Hamilton, and will be part of an important new route to Coney Island.

The principal line of the B. R. T. in New York will be that already described, running from the center of Brooklyn under the East River and via Broadway and Seventh Ave. to 59th St., the Queensborough Bridge and to Astoria and Flushing. This will be a four-track line in Manhattan above City Hall (Park Place).

From a certain point of view, the linking up of the New York end of the three down-town East River bridges, the old Brooklyn Bridge, the Manhattan just above it, and the Williamsburg Bridge, a mile farther up the river, is one of the most interesting features of the whole scheme. For years the crowding and congestion at the ends of the Brooklyn Bridge were worse than even on the elevated and subway lines. Nearly all the travel from the lines of the B. R. T. was concentrated at this one bridge and brought over to a stub-end terminal at the New York end. In an attempt to provide better means of communication between Brooklyn and New York, the Williamsburg Bridge was built and opened in 1905 and the Manhattan Bridge in 1908. No provision was made, however, for the operation of these bridges or their proper connection with any of the existing lines of communication, and the people from Brooklyn have been brought over to the New York ends and dumped there, to make the best of their way to their destination. The travel between Brooklyn and New York is nearly all toward New York in the mornings and toward Brooklyn at night, all four of the East River bridges providing for lines of rapid transit (two or four tracks) as well as for street cars, ordinary vehicular traffic and pedestrians.

To eliminate the stub-end terminals the so called Centre St. loop was planned to connect up the New York Ends of these three bridges, and its construction was started in 1907, though no arrangement was made for its use. Now, however, it is to be completed and further extended down along the New York side to a connection with the new tunnel which is to connect the B. R. T. with its Broadway line. This will enable all the trains to circulate, coming over on one bridge, continuing and returning via another instead of coming into a terminal in the congested district and having to back out.

There will be also another new route established under 14th St., New York, and the East River, to the easterly section of Brooklyn (East New York).

FARES

The contracts between the city and the two operating companies provide for a single fare of five cents on each system, with free transfers at intersecting points for a continuous ride in the same general direction. On the Brooklyn system, transfers will be exchanged between the elevated lines and the subway lines, but on the Interborough only such transfers as are now given will be provided between the elevated railroads and the subway. On the existing lines, as they stand today, the longest ride obtainable for five cents is through the subway from Atlantic Ave., Brooklyn, to Van Cortlandt Park or 242nd St. on the Broadway branch, a distance of 17½ miles. Under the dual system, as the new system has been commonly called, it will be possible to travel over the Interborough subway from the terminus of the White Plains Road line, near the northern city boundary, the whole length of the Bronx and Manhattan, under the East River to Brooklyn, and through the Eastern Parkway subway and its extensions to New Lots Ave.—a distance of about 26 miles—for one fare and without change of cars.

The longest ride on the Brooklyn system will be from Flushing, at the end of the Corona branch, to and across the Queensborough Bridge, through the Broadway subway in Manhattan, under the East River to Brooklyn and through the Fourth Ave. subway and its connections to Coney Island, about 21 miles, for five cents.

The fare from the center of Brooklyn to Coney Island had always been 10 cents (15 cents from New Yorw) up to within the last few years, when a general agitation for its reduction was started.

As soon as the connections of the Fourth Ave. subway in Brooklyn with the elevated lines are made and through-train operation is possible from Manhattan to Coney Island, the five-cent fare between these points will apply. This, is is estimated, will take about 18 months.

CHANGES IN METHODS OF COMMUNICATION IN NEW YORK

Before leaving the general subject of routes, it may not be amiss to call attention to the radical change in the character of the means of communication between New York City proper (Manhattan) and the surrounding territory, which has taken place in the last six or eight years. Direct land communication has never been possible except to the north, while the most densely populated of the surrounding districts have been to the east in Brooklyn and the west in New Jersey, with which communication was only possible by means of boats of one kind or another, and from both of which districts enormous numbers of people come to Manhattan daily.

Brooklyn was connected with Manhattan by means of the famous Brooklyn Bridge as long ago as 1883; but with the completion of that structure progress along these lines stopped for almost a quarter of a century. Within the last eight years, however, three more bridges have spanned the East River and six pairs of railway tunnels have been put into service under the rivers, one pair more has been built, three pairs are to be built under the present scheme, making four bridges and ten pairs of tunnels for railways, besides which there have been built two tunnels for gas and one for water-supply, and thus making practical the direct physical connection of Manhattan, by land lines of communication with the populous districts to the east and west.

Collection and Disposal of City Refuse, Washington, D. C.

By J. W. Paxton*

SYNOPSIS—This is the fourth and last article describing the method of operation of the Washington Street Cleaning Department. Previous articles appeared in Engineering News *of July 9, Aug. 6 and Aug. 27, 1914. The present article describes the collection and handling of garbage and refuse, which is done by contract, from the point of view of the city inspectors and supervisors.*

The collection and disposal of city refuse for the District of Columbia is done by contract, under the supervision of the Street Cleaning Department. Five contracts are let; namely, for the collection and disposal of garbage, ashes, miscellaneous refuse, dead animals and night soil.

The main features of the contracts are as follows:

Garbage—(1) Collections and disposal of garbage are made daily, including Sundays, from such hotels, apartment houses, markets, and other like places within the City of Washington and such of its suburban sections as may be designated, from time to time, by the Commissioners of the District of Columbia.

(2) Collections and disposal of garbage are made daily, excluding Sundays, from May 16 to Oct. 15, both days inclusive, and three times a week from Oct. 16 to May 15, both days inclusive, from all places not embraced in the preceding paragraph within the existing fire limits of the District of Columbia and certain of the more thickly populated sections on the outside of and adjacent to the fire limits.

(3) Collections and disposal of garbage are made three times a week from May 16 to Oct. 15, both days inclusive, and semiweekly from Oct. 16 to May 15, both days inclusive, from all places not included in the preceding paragraphs, in the City of Washington and its suburbs, as such suburbs may, from time to time, be designated by the Commissioners of the District of Columbia.

(4) The collection of garbage is made in wagons carrying a covered iron box which is lifted from the wagons and loaded on cars at the transfer station. This box containing the garbage is then shipped by rail to the disposal plant owned by the contractor, located about 32 miles from Washington, and the garbage is there disposed of by the reduction process.

Ashes—(1) Collections and disposal of ashes within the existing fire limits of the District of Columbia and certain of the more thickly populated sections outside of and adjacent to the fire-limits, are made weekly, from Apr. 16 to Oct. 31, inclusive, and semiweekly from Nov. 1 to Apr. 15, inclusive, from private residences, boarding houses, lodging houses not exceeding 25 rooms, and apartment houses containing not more than four families, and other like places, as may be designated by the Commissioners of the District of Columbia.

(2) Collections and disposal of ashes are made from all private residences and such other like places corresponding to those included in the preceding paragraph from the remainder of the City of Washington and its suburban sections, as said suburban sections may from time to time be designated by the Commissioners of the District of Columbia, weekly, throughout the entire year.

(3) The collections are made in wagons with canvas covers and disposed of by filling low ground on the outskirts of the city.

Refuse—(1) Collections and disposal of miscellaneous refuse in the City of Washington and its more densely populated suburbs, as such suburbs may from time to time be designated by the Commissioners of the District of Columbia, are made once a week from all private residences, boarding houses, and lodging houses with not to exceed 25 rooms, and apartment houses containing not to exceed four families, and other like places, as may be designated by the Commissioners of the District of Columbia, and from such public waste boxes as may be established by the street-cleaning division in the machine-swept section of the City and District.

(2) The collections are made in wagons suitable for this purpose and what is not salable is disposed of at an incinerating plant owned by the contractor.

Dead Animals—(1) The collection and disposal of dead animals daily, including Sundays, throughout the year, from every part of the District of Columbia, is required upon notification to the contractor of the existence of said dead animals.

(2) The collections are made in vehicles suitable for the purpose, and the disposal is accomplished by the reduction process at a plant owned by the contractor located about 4 miles from the city.

Night Soil—(1) The collection and disposal of night soil from all privies, and from all streets, avenues, alleys, roads and open lots in the District of Columbia is required upon receipt of notice from the Superintendent of Street Cleaning.

(2) The collections are made in air-tight receptacles designed for that purpose and transported therein on barges about 8 miles from the city and there used as fertilizer on a farm.

Ashes from Public Buildings—(1) The collection and disposal of ashes and refuse from buildings under the control of the Commissioners of the District of Columbia is required as such may accumulate.

(2) This work is done by contract under the direction of this division but paid for from the appropriation for the maintenance of each building in proportion to the quantity removed.

Collection

Householders' Instructions—The householders are required to conform to the police regulations as to receptacles, separation of material and accessibility. Cards of instructions to householders containing extracts from the police regulations are distributed on request or to those who show evidence of the need of instruction.

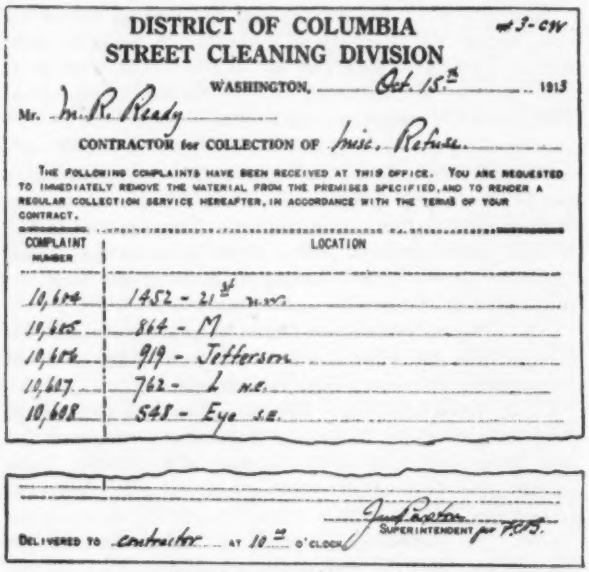
The contractor is required to call on the same days each week, collections to be made at any time between

*Superintendent of Street Cleaning, Washington, D. C.

7 a.m. and 6 p.m.; and he is to make free use of horn or gong as a signal of his presence. Failure of the contractor to promptly and properly collect material lawfully offered costs him a fine of $1 to $2 for each neglect.

The supervision of this work is in charge of one man, reporting directly to the Superintendent. He has under him a force of five inspectors and a complaint clerk.

Inspection—It is manifestly impossible, and it is not considered necessary, for this force to supervise the collection of every class of material from every house. Inspection can be made in a general way, information obtained as to whether each wagon is on its regular route on the schedule day, special attention being given to



DISTRICT OF COLUMBIA
STREET CLEANING DIVISION

#3-CW

WASHINGTON, Oct. 15th 1913

Mr. Jno. R. Ready

CONTRACTOR for COLLECTION OF Misc. Refuse.

THE FOLLOWING COMPLAINTS HAVE BEEN RECEIVED AT THIS OFFICE. YOU ARE REQUESTED TO IMMEDIATELY REMOVE THE MATERIAL FROM THE PREMISES SPECIFIED, AND TO RENDER A REGULAR COLLECTION SERVICE HEREAFTER, IN ACCORDANCE WITH THE TERMS OF YOUR CONTRACT.

COMPLAINT NUMBER	LOCATION
10,604	1452 - 21st N.W.
10,605	864 - M
10,606	919 - Jefferson
10,607	762 - L n.e.
10,608	548 - Eye s.e.

DELIVERED TO contractor AT 10m O'CLOCK

Jno. Poston SUPERINTENDENT per T.D.S.

Fig. 1. Daily List of Complaints as Supplied to Contractors

those which are or likely to be behind, and all complaints are investigated.

The investigation, however, being after the cause of the complaint, it is sometimes difficult to ascertain whether the fault was the householder's, in not making the proper separation or the waste accessible, or the collector's.

Complaints—In spite of this fact, the work of holding the contractor to the specifications depends to a large extent on complaints received from householders; each acting on his own premises as an inspector. Unfortunately, complaints received cannot be accepted as an absolute criterion of conditions. The householders often do not conform to the regulations, and service is refused for that reason.

During the year ending June 30, 1912; 693 garbage, 1196 ash, and 2985 refuse complaints were investigated. Of the total garbage complaints, but 38 or 5½% were found, on investigation, to be the fault of the contractor; 266 or 38.4% were found to be the result of violations on the part of the householder of the police regulations regarding the disposal of refuse, while in 389 cases, or 56.1%, the fault could not be definitely placed.

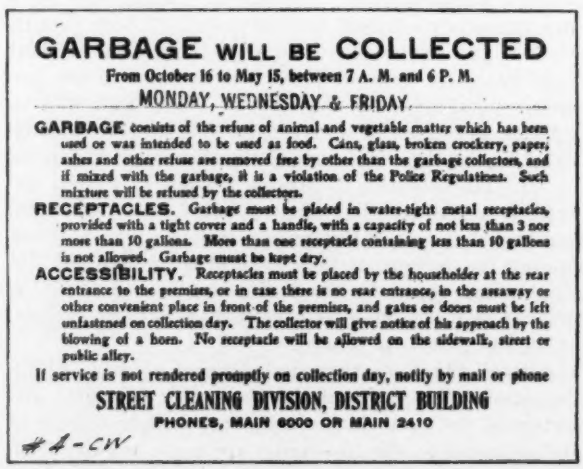
In the case of ashes but 115 complaints or 9.6%, proved to be the fault of the contractor; 802 or 67% are chargeable to the failure on the part of the householder to observe the regulations, principally regarding accessibility, while 279 or 23.4% are classed as doubtful. In the refuse service, 730 complaints, or 24.5%, were found to be the fault of the contractor, 836 or 28%, the fault of the householder, while 1419, or 47.5%, were classed as doubtful.

Acting on Complaints—Upon receipt of either a garbage, ash or refuse complaint, the papers referring to the case are placed in an open-sided envelope, 4x9½ in., which is given a complaint number, and the blanks for location and date filled in. These envelopes are then turned over to the inspector in whose district the complaint originated. The information suggested on the face of the envelope (including a description of premises, how collections are made, date of last collection, etc.) is obtained and any additional observations written under remarks on the back, together with the inspector's conclusion as to the location of the fault. When fines are fixed, they are considered as liquidated damages and not as penalties. The envelopes are filed according to location of the complaint and cross-indexed by number and date.

Complaint Record—A monthly record of such complaints is also kept on a Complaint Record, 3⅝x8½ in., which gives a summary of requests and complaints received each day, the results of the investigations as to fault and fines imposed.

The form shown in Fig. 1 is a list supplied each day to the contractor of complaints received at the office, which also serves as an order to collect the material immediately and as a warning against such failure in the future. The actual size of the card is just twice the reproduction.

Collections—The form shown in Fig. 2 is a notice issued by contractors, in accordance with specifications, to householders previous to any change in collection days. Fig. 3 is a summary of daily reports from contractors showing the working force and the amount collected. The actual size is 3⅝x8¼ in.



GARBAGE WILL BE COLLECTED

From October 16 to May 15, between 7 A. M. and 6 P. M.

MONDAY, WEDNESDAY & FRIDAY

GARBAGE consists of the refuse of animal and vegetable matter which has been used or was intended to be used as food. Cans, glass, broken crockery, paper, ashes and other refuse are removed free by other than the garbage collectors, and if mixed with the garbage, it is a violation of the Police Regulations. Such mixture will be refused by the collectors.

RECEPTACLES. Garbage must be placed in water-tight metal receptacles, provided with a tight cover and a handle, with a capacity of not less than 3 nor more than 10 gallons. More than one receptacle containing less than 10 gallons is not allowed. Garbage must be kept dry.

ACCESSIBILITY. Receptacles must be placed by the householder at the rear entrance to the premises, or in case there is no rear entrance, in the areaway or other convenient place in front of the premises, and gates or doors must be left unfastened on collection day. The collector will give notice of his approach by the blowing of a horn. No receptacle will be allowed on the sidewalk, street or public alley.

If service is not rendered promptly on collection day, notify by mail or phone

STREET CLEANING DIVISION, DISTRICT BUILDING

PHONES, MAIN 6000 OR MAIN 2410

#4-CW

Fig. 2. Card Sent to Householders by Contractor Previous to Any Change in Collection Days

Collections of night soil and dead animals are made only on request for such service. The contractor is supplied with a list of requests received, in the form of an order to make the collections, which he is required to return with a statement that the collections have been made giving the date, or a reason for failure.

Inspectors' Report—The form, Fig. 4, is a daily report, 4½x7¼ in., turned in by each inspector and shows

STREET CLEANING DIVISION

Service Record

RECORD OF *Garbage* SERVICE

FOR MONTH OF *September* 1913.

DATE	WORKING VEH	WORKING MEN	WORKING HORS	COLLECTIONS LOADS	COLLECTIONS TONS	COLLECTIONS POUNDS.
1	98	115	120	254	305	457
2	86	104	114	167	192	707
3	86	105	110	166	199	1685
4	85	104	114	161	174	407
28	11	14	18	17	23	850
29	86	102	110	193	235	250
30	73	90	102	132	146	407
31						
TOTAL				5068	1550	

FIG. 3. SUMMARY OF REPORTS FROM CONTRACTORS

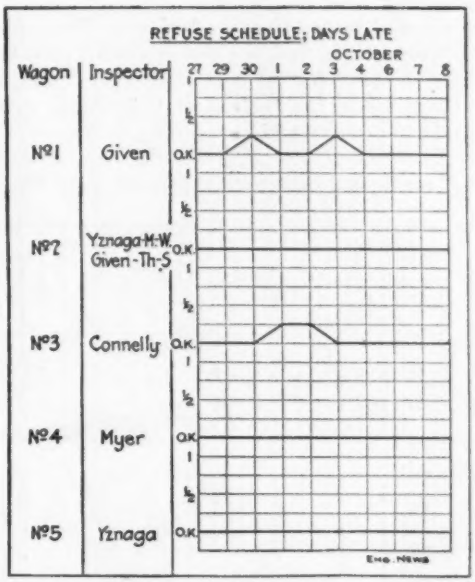


FIG. 5. PROFILE SHOWING CONDITION OF REFUSE WAGONS AS TO THEIR WORKING SCHEDULE

complaints investigated, general inspection, and whether or not contractors' wagons are behind the schedule. Districts having been set by the contractor to be collected on certain days, the inspector reports whether the wagon is O. K., ¼ day late or ½ day late, etc.

SCHEDULE PROFILES—This record is plotted on profile paper (Fig. 5). If any wagon driver shows a continued tendency to be behind and the contractor does not upon request supply assistance, assistance is furnished by the Superintendent of Street Cleaning and charged to the contractor.

GRAPHICAL RECORDS—From the Complaint Record and the Service Record (Fig. 3), a profile (Fig. 6) is made up giving graphically the information recorded on

#6-cw

STREET CLEANING DIVISION

WASHINGTON, D. C.

REFUSE INSPECTOR'S REPORT.

DATE *Oct 14th, 1913*

ARR	DEP	LOCATION	
8	8	#7 Garbage	
8	8	#3 Refuse	
9	9	#25 Refuse	
9	9	#22 Refuse	
2	4	#12 Refuse	O.K.
4	4	#22 Refuse	¼ day late
4	4	#25 Refuse	O.K.
4	5	#3 Refuse	O.K.

INSPECTOR *B. W. Connelly.*

FIG. 4. REPORT FROM INSPECTOR, SHOWING PLACES VISITED AND CONDITION OF COLLECTION

these two records. This profile might well be considered a barometer of the collection service. Thus at certain seasons, a large number of complaints may always be expected, but so long as collections increase and the number of complaints charged to the contractor does not materially increase, the service is probably at a high standard.

In October, 1912, the total ash complaints show a considerable increase on account of cold weather over September, while the collections show an increase of about 5000 cu.yd. The complaints which found the fault with the contractor, however, show only a nominal increase over September.

The refuse profile shows, in May, 1912, the other condition, collections being only slightly more than in April, while complaints increased about 66%, those charged against the contractor, however, increasing about 125%. This indicates the service was at fault, the additional accumulation, due to spring house cleaning, overtaxing the resources of the contractor.

The general upward trend of the collection curve of the refuse profile and the corresponding downward movement of the line of total complaints shows that better service is being rendered.

PROPOSED MUNICIPAL COLLECTION—With a view to obtaining less objectionable, more efficient and more economical services than rendered by contractors, the Commissioners have recommended to Congress that an appropriation of $10,000 be made for the purpose of investigating and reporting on the collection and disposal of city waste, including the preparation of plans and specifications for the construction of disposal plants. Congress has not, as yet, seen fit to make this appropriation.

ADVANTAGES OF MUNICIPAL DISPOSAL WORKS—It is estimated that the contractors for the disposal of city waste have invested in collecting equipment and disposal plants, several hundred thousand dollars, which they must have figured on recovering from the amounts received from the District of Columbia, for the services rendered during the five-year term of their contracts, as these in-

vestments will be practically valueless on the expiration of the contracts, if they are not successful in obtaining the same contracts for the next term of five years.

In other words, the District of Columbia is probably paying to the contractors, in addition to the cost of the work and the contractors' profit, the cost of complete disposal plants and collection equipment every five years,

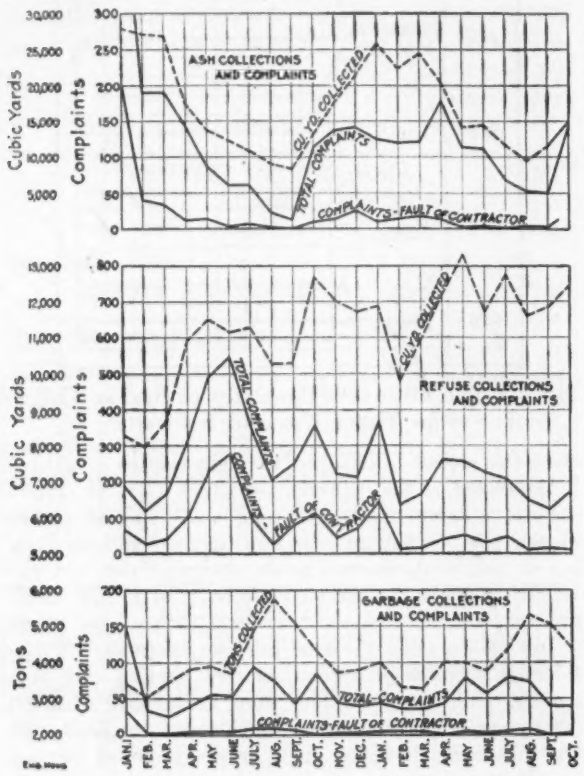

ASH COLLECTIONS AND COMPLAINTS
Cubic Yards
Complaints
CU. YD. COLLECTED
TOTAL COMPLAINTS
COMPLAINTS - FAULT OF CONTRACTOR
REFUSE COLLECTIONS AND COMPLAINTS
GARBAGE COLLECTIONS AND COMPLAINTS
Tons
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT.

FIG. 6. GRAPHICAL YEARLY RECORD OF COLLECTION COMPLAINTS

whereas the disposal plants, if owned by the District, would probably have a life of 40 or 50 years. It is believed that the District of Columbia should, at least, own the disposal plants, which could be operated by the District and the collection of city wastes could be let to contractors, or the whole service could be let by contract on the basis of the contractors leasing the disposal plants from the District.

⁂

Electricity in the Anthracite Industry—The introduction of electricity in any great quantity into the mines is not more than two decades old. The first electrical installation was made in 1887 by the Pennsylvania R.R. In 1889 the Thompson-Houston Co. installed a locomotive and a generating station in the Erie Colliery of the Hillside Coal & Iron Co. and this locomotive was in continuous service until 1911. The first electric pump was installed in 1890, and it has been in continuous operation ever since.

The present total capacity of supply purchased or generated is 105,400 hp. compared with 440,300 hp. produced by steam for direct use. Today there are 169 miles of wooden pole lines above ground and 754 miles of trolley wire below ground in the anthracite mines. There are 951 electric locomotives using an estimated amount of over 60,000 hp. The other electrically operated equipment requires 19,170 hp. for breakers and miscellaneous machinery, 23,280 hp. for electric hoists, 38,500 for electrically driven pumps, 2920 for coal-cutting machines, 3650 for lighting and about 100 for heating. There are now five breakers equipped with individual motor drives, and others are under course of construction.

Computing Maximum Bridge Stresses by a Maximum-Moment Table

BY J. P. J. WILLIAMS*

The accompanying table has been devised to save a large amount of the labor required to compute live-load stresses in beams and trusses due to Cooper's standard loadings. It gives directly, or by interpolation, the *maximum bending moment per rail produced by E-50 loading* at intermediate points of spans of various lengths. The *number of the critical wheel* which gives the greatest bending moment is also indicated, by black-face figure placed at the upper left when the shorter segment l_1 is the left segment, and at the upper right when l_1 is the right segment (the engines are always assumed to be headed toward the left). The moments are given for every 5-ft. interval along the span, and for span lengths varing by 5 ft. To aid in the work of interpolating, the *change of bending moment per foot change* of distance (l_1) from the nearer support is given by a figure above the moment.

The results can be relied upon as accurate within 1%, and are, of course, available for any specified Cooper's loading by simply multiplying by the ratio of the given loading to E-50. All figures in both table and examples are given in 1000-lb. units.

The well known relation between floor-beam load and two-panel bending moment makes it possible to compute maximum *floor-beam loads* from the values in the table. It will also be proved that there is a definite relation between *maximum shears* in truss panels and maximum bending moments in certain equivalent spans, also between the latter and maximum moments for computing *web stresses* in trusses with inclined chords. The field of usefulness of such a table is thus greatly extended, and includes short methods of computing not only maximum chord stresses but also maximum web stresses in all ordinary trusses in addition to the usual applications to girders and beams.

The method of using the table and applications to definite practical problems will be detailed, and the new relations and formulas fully developed. Incidentally, it will be shown that the limiting value for l_1, the shorter segment of the span, is 142 ft. because a constant position of loading and a simple formula will give maximum bending moments when l_1 exceeds that value.

MAXIMUM BENDING MOMENTS

Example 1. What are the maximum E-50 live-load bending moments at 5-ft. intervals in a 50-ft. girder? By entering the table for the known values of segments l_1 and l_2, which for this case are found in the table without interpolation, there results:

Point	l_1, ft.	l_2, ft.	M in 1000-lb. units
1	5	45	460
2	10	40	795
3	15	35	1024
4	20	30	1150
5 center	25	25	1180

The value of 1180 for the center section is practically equal to the absolute maximum bending moment near the center. For all spans greater than about 25 ft. in length, the center bending moment is within a small percentage of the absolute maximum bending moment.

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*Formerly Assistant Professor of Structural Engineering, University of Minnesota, Minneapolis, Minn.

TABLE OF MAXIMUM BENDING MOMENTS FOR E 50 LOADING

Values given in thousand pound-foot units for one rail. Upper figures are differences per foot change in l_1 for interpolation. Blackface figures denote number of critical wheel.

Shorter Segment l_1

Longer Segment $l_2 = l - l_1$	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	110	120	130	140
250		2	3 364 5660	3 357 7480	4 350 9270	4 343 11020	5 347 12740	5 316 14470	6 334 16200	7 342 17870	8 332 19580	8 338 21240	9 334 22930	10 340 24600	11 340 26300	11 364 28000	12 316 29800	12 324 31400	13 316 33020	13 330 34600	14 300 37900	15 310 40900	17 310 44000	18 47100
225		2	3 332 5160	3 326 6820	4 314 8450	4 318 10020	5 306 11610	5 312 13140	6 300 14700	7 316 16200	8 312 17780	8 298 19340	9 294 20830	10 320 22300	11 300 23900	11 320 25400	12 300 27000	12 300 28500	12 280 30000	13 280 31400	14 270 34200	15 290 36900	17 280 39800	18 42600
200		2	3 300 4660	3 292 6160	4 288 7620	4 282 9060	5 272 10470	5 273 11830	6 280 13200	7 284 14600	8 262 16020	9 280 17330	9 274 18730	10 270 20100	11 278 21450	11 276 22840	12 276 24220	12 250 25600	12 250 26850	13 250 28100	14 250 30600	15 250 33100	17 240 35600	18 38000
175		2	3 266 4160	3 260 5490	4 256 6790	4 244 8070	5 240 9290	5 248 10490	6 240 11730	7 244 12930	8 240 14150	9 236 15350	9 254 16530	11 240 17800	11 244 19000	12 240 20220	12 236 21420	12 220 22600	12 220 23700	13 220 24800	14 220 27000	15 200 29200	17 210 31200	18 33300
160		2	3 244 3860	3 242 5080	4 232 6290	4 232 7450	5 218 8610	5 226 9700	6 218 10830	7 224 11920	8 224 13040	9 220 14160	9 226 15260	11 222 16390	11 230 17500	12 230 18650	12 200 19800	12 200 20800	12 200 21800	13 200 22900	14 190 24900	15 180 26800	17 210 28600	18 30700
150		2	3 232 3650	3 226 4810	4 218 5940	4 218 7030	5 208 8120	5 210 9160	6 208 10210	7 214 11250	8 202 12320	9 214 13330	9 214 14400	11 203 15470	12 210 16530	12 208 17580	12 196 18620	12 180 19600	12 180 20500	13 200 21400	14 180 23400	15 180 25200	17 180 27000	18 28800
140		3	3 216 3440	3 216 4520	4 206 5600	4 200 6630	5 196 7630	5 192 8610	6 206 9570	7 196 10600	8 200 11580	9 194 12580	10 194 13550	11 198 14520	12 200 15500	12 200 16500	12 180 17500	12 190 18400	12 170 19350	13 170 20200	14 180 21900	15 160 23700	17 170 25300	18 27000
130		3	3 203 3230	3 204 4250	4 188 5260	4 188 6200	5 178 7140	5 184 8030	6 190 8950	7 188 9900	8 178 10840	9 176 11730	10 202 12610	11 176 13620	12 200 14500	12 180 15500	12 160 16400	12 172 17200	12 168 18060	13 160 18900	14 150 20500	15 155 22000	17 23550	130
120		3	3 190 3012	3 188 3960	4 172 4900	4 180 5760	5 160 6660	5 178 7460	6 170 8350	7 174 9200	8 162 10070	9 172 10880	10 182 11740	11 168 12650	12 176 13500	12 164 14380	12 156 15200	13 174 15980	13 150 16850	13 147 17600	14 134 19070	15 20410	120	
110		3	3 172 2800	3 174 3660	4 162 4530	4 160 5340	5 152 6140	6 158 6900	7 158 7690	7 158 8480	8 158 9270	9 170 10060	10 152 10910	11 166 11670	12 160 12500	12 160 13300	12 140 14100	13 136 14800	13 144 15480	13 131 16200	14 17510	110		
100		3 165 1744	3 160 2570	3 156 3370	4 150 4150	5 148 4900	5 138 5640	152 13 6330	142 14 7090	144 14 7800	142 14 8520	156 13 9230	140 13 10010	11 148 10710	12 144 11450	12 146 12170	12 142 12900	13 128 13610	13 114 14250	13 14820	100			
95		3 158 1660	3 152 2450	4 152 3210	4 140 3970	5 148 4670	140 13 5410	140 13 6110	136 13 6810	144 13 7490	134 13 8210	142 13 8880	142 13 9590	130 13 10300	12 150 10950	12 120 11700	12 122 12300	13 130 12910	13 13560	95				
90		3 150 1580	3 142 2330	4 146 3040	4 134 3770	5 144 4440	130 13 5160	138 13 5810	138 13 6500	130 13 7190	128 13 7840	136 13 8480	130 13 9160	142 13 9810	12 124 10520	12 116 11140	12 116 11720	13 12300	90					
85		3 144 1498	3 136 2210	4 136 2890	4 124 3570	5 146 4190	134 13 4920	126 13 5590	124 12 6220	128 13 6840	124 13 7480	122 12 8100	126 13 8710	106 13 9340	126 12 9870	12 124 10500	12 11120							
80		3 134 1417	3 129 2085	4 127 2733	4 121 3365	140 13 3970	124 13 4670	126 13 5290	116 12 5920	120 12 6500	118 12 7100	110 12 7690	124 12 8240	112 12 8860	104 12 9420	12 9940								
75	2 130 690	3 125 1337	3 120 1965	4 119 2565	4 110 3163	140 13 3710	118 13 4410	110 12 5000	116 12 5550	116 12 6120	108 12 6700	110 12 7240	106 12 7790	100 12 8320	12 8820								
70	2 122 645	3 117 1255	3 112 1842	4 112 2400	4 110 2960	118 13 3510	110 13 4100	112 12 4655	100 12 5215	109 12 5715	104 12 6240	100 11 6760	96 11 7260	11 7740										
65	2 113 602	3 109 1167	3 106 1710	4 102 2240	4 102 2750	102 12 3260	110 12 3770	96 12 4320	100 12 4800	98 12 5300	96 11 5790	94 11 6270	11 6740											
60	11 103 566	3 101 4079	3 96 1582	4 94 2063	4 90 2535	5 97 2983	94 13 3470	92 13 3940	98 11 4400	86 11 4890	86 11 5320	11 5750												
55	11 95 532	12 92 1005	12 86 1467	12 85 1895	4 84 2320	12 86 2740	90 13 3170	80 12 3620	72 12 4020	96 13 4380	11 4860													
50	11 88 496	12 85 938	12 79 1362	12 77 1755	12 78 2140	12 80 2530	74 13 2930	72 13 3300	72 13 3660	12 4020														
45	2 81 460	3 78 865	12 71 1255	12 70 1610	12 70 1960	12 72 2310	70 13 2670	64 13 3020	13 3340															
40	2 75 420	3 70 795	3 64 1144	12 63 1462	12 62 1780	12 63 2090	59 13 2405	13 2700																
35	2 67 378	3 62 715	3 57 1024	4 56 1310	4 54 1590	13 55 1860	13 2135																	
30	2 58 339	3 54 631	3 50 899	4 48 1150	4 45 1390	13 1615																		
25	2 52 294	3 45 555	3 40 782	4 40 982	4 1180																			
20	2 44 250	35 4 460	3 36 645	4 823																				
15	2 37 188	3 27 375	3 512																					
10	2 25 125	3 250																						

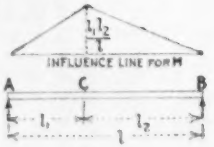

FIG 1

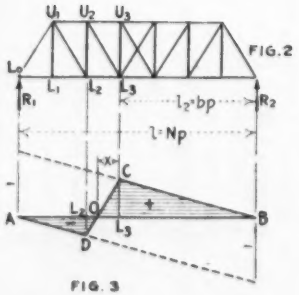

FIG. 3

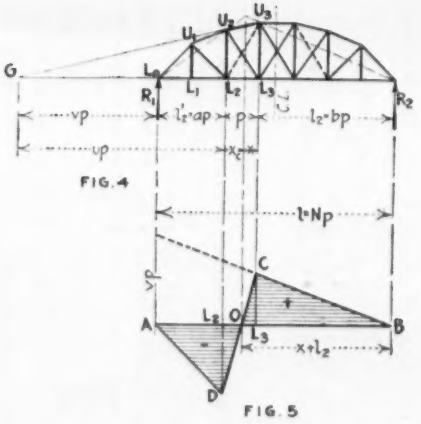

FIG. 4

FIG. 5

FORMULAS FOR USE OF TABLE

Max. Moment at C in Beam AB, Fig. 1 = M given by table direct

Max. Floorbeam Reaction = $M \frac{l_1 + l_2}{l_1 l_2}$, M taken for l_1 and l_2 equal to the adjoining stringer spans

Max. Shear in Truss Panel = $\frac{M}{p}$, M taken for $l_1 = x = \frac{bp}{N-1}$ and $l_2 = bp$, Fig. 2

Max. Mom. for Main Web Stress = vM, M taken for $l_1 = x = \frac{bpv}{Nv-v}$, Fig. 4, and $l_2 = bp$

Max. Mom. for Counter Stress = $(v+1)M$, M taken for $l_1 = x_c = p+$, Fig. 4, and $l_2 = ap$

Example 2. What is the maximum E-50 live-load bending moment at the center of a 76-ft. span? For this case

$$l_1 = l_2 = 38 \text{ ft.}$$

For $l_1 = l_2 = 35$ ft., M =	2135
Add for change in l_1, 3×58 =	174
Add for change in l_2, $^2/_5 \times 270$ =	162
M =	2471 *per girder.*

The value of 58 for the difference per foot change in l_1 was obtained from the upper figure 59 found when $l_1 = 35$ ft. and $l_2 = 40$ ft. by allowing for the small difference due to the fact that l_2 is less than 40 ft. The value 270 was easily found by subtracting the two values in the vertical column $l_1 = 35$ ft. for $l_2 = 35$ ft. and $l_2 = 40$ ft. An estimated increase might have been made in this quantity, since l_1 is really 38 ft. instead of 35 ft., but this is generally unnecessary.

Limiting Value of Left Segment—The table was not carried beyond the value $l_1 = 140$ ft. because when this shorter segment l_1 becomes 142 ft. or more the bending moment is maximum for a fixed position of the loading, i.e. engines on shorter segment and head of uniform load 142 ft. from nearer support, as will now be proved. Let

W_e = total weight per rail of the two engines;
= 355 for E-50 loading;
w = uniform train load per rail, per ft.;
= 2.5 for E-50 loading;
W = total load on span l;
y = length of uniform train load on span;
k = 57.6 ft. = distance from center of gravity of the two engines to the head of uniform load.

The equation for bending moment M can be written by considering the *right* segment l_2, the uniform train load covering that segment completely:

$$M = R_2 l_2 - \tfrac{1}{2} w l_2^2 = l_2 (R_2 - \tfrac{1}{2} w l_2)$$

Thus the bending moment is evidently maximum when R_2 is maximum, and

$$R_2 = W - R_1 = W_e + wy - \left(\frac{W_e (k + y) + \frac{1}{2} w y^2}{l}\right)$$

By placing the first derivative with respect to the variable y equal to zero to find the maximum, there is obtained

$$l - y = \frac{W_e}{w} = \frac{355}{2.5} = 142 \text{ ft.} \qquad \text{Q.E.D.}$$

Thus whenever l_1 is greater than 142 ft., the bending moments are maximum for a fixed position of the loading, and the value of reaction R_2 due to E-50 loading will be:

$$R_2 = \frac{355\,(142 - 51.6) + 2.5\,(l - 142)\left(\frac{l}{2} + 71\right)}{l}$$

$$= \frac{4800}{l} + 1.25\,l$$

Therefore

$$M = l_2 \left(R_2 - \frac{2.5}{2} l_2\right) = l_2 \left(\frac{4800}{l} + 1.25\,l_1\right) \quad (1)$$

Example 3. What is the maximum E-50 live-load bending moment at the center of a 300-ft. span? For this case, using Eq. (1),

$$l_1 = l_2 = \frac{300}{2} = 150 \text{ ft. and } l = 300 \text{ ft.}$$

$$M = 150 \left(\frac{4800}{300} + \overline{1.25 \times 150}\right) = 30,430$$

Maximum Floor-Beam Reactions

The maximum floor-beam reaction R is obtained from the value of M for l_1 = length of one stringer span and l_2 = length of the adjacent stringer span by the usual well known formula

$$R = M \frac{l_1 + l_2}{l_1 l_2} \quad (2)^*$$

Or, for equal spans,

$$l_1 = l_2 = p$$

$$R = \frac{2M}{p} \quad (2a)^*$$

Example 4. Compute the maximum E-50 live-load floor-beam reaction for equal adjacent stringer spans of 25 ft. Read M directly from table with $l_1 = l_2 = 25$ ft. Then, by eq. (2a),

$$R_2 = \frac{2M}{p} = 2 \times \frac{1180}{25} = 94.4$$

Example 5. Compute the maximum E-50 live-load column concentration for adjacent viaduct spans of 30 ft. and 60 ft. Read M directly from table with $l_1 = 30$ ft., $l_2 = 60$ ft. By eq. (2),

$$R_2 = M\left(\frac{l_1 + l_2}{l_1 l_2}\right) = 2983 \left(\frac{30 + 60}{30 \times 60}\right) = 149.2$$

Shears and Web Stresses (Horizontal Chords)

Consider a simple truss span, Fig. 2, of N equal panels, i.e., length $l = Np$, and let

$l_2 = bp$ = distance from right end of critical panel p to right end of span;
x = distance from right end of panel p to the neutral point of no shear in the panel.
$M_s = M$ from the table for $l_1 = x$, $l_2 = bp$;
S = desired maximum E-50 live-load shear in the panel.

The value x can be found either analytically or graphically. By equating to zero the shear in the given panel produced by a single load in that panel, x is found to be:

$$x = \frac{l_2}{N - 1} \quad (3)$$

Or the graphical construction of the influence line as in Fig. 3 locates this point of zero shear and the value of x can be scaled.

The influence line for shear in panel $L_2 L_3$ of the truss of Fig. 2 is drawn in the usual way in Fig. 3. The triangular portion OCB would be used to give maximum positive shear, and it is found that for practically all cases the maximum will occur for Cooper's loadings with no wheels in advance of the point O. Therefore, since this triangular shear influence line OCB is exactly similar to a triangular influence line for bending moment at L_3 of a beam $OB = x + l_2$ in length, *the ratio of the desired maximum shear S to the maximum bending moment M_s (obtainable from the table) is the same as the ratio of the ordinates to these influence lines.* These ordinates at L_3 are:

Shear in panel, $L_3 C = \frac{l_2}{l}$

Bending moment at L_3 of OB,

$$L_3 C = \frac{x l_2}{x + l_2} = \frac{l_2}{1 + \frac{l_2}{x}} = \frac{l_2}{1 + \frac{l_2 (N - 1)}{l_2}} = \frac{l_2}{N}$$

*See Johnson Bryan & Turneaure's "Modern Framed Structures," Part 1, p. 205.

Since the ratio of these ordinates is $\frac{N}{l}$, the shear S will be:

$$S = \frac{N}{l} M_s = \frac{M_s}{p} \qquad (4)$$

This equation will evidently give results always on the side of safety. For the case of a short through plate-girder with short panels, wheel 1 may be in advance of the neutral point O for panels near the center, but the error is negligible.

Example 6. Compute the maximum E-50 live-load web stresses in a 150-ft. Pratt truss of 6 panels, 28 ft. deep, with horizontal chords. Using the bending-moment table for values M_s and eq. (3)

$$x = \frac{l_2}{N-1} = \frac{l_2}{5}, \text{ and eq. (4) } S = \frac{M_s}{p} = \frac{M_s}{25}$$

the following tabular form of computation can be adopted, noting that i = inclined length of diagonals = 37.5 ft.:

Panel No.	$l_2 = bp$	$l_1 = x = \frac{l_2}{5}$	M_s (from table)	$S = \frac{M_s}{25}$	Stress $= \frac{Si}{h} = \frac{37.5}{28} S$	Member
1	125 ft.	25'	5080	203.2	−272	L_2U_1
2	100	20	3370	134.8	+181	U_1L_2
3	75	15	1965	78.6	+105	U_2L_2
4	50	10	938	37.5	+ 50	L_2U_2
		Maximum floor-beam reaction			+ 94.4	U_1L_1
		Shear in panel 3			− 78.6	U_2L_2
		Shear in panel 4			− 37.5	U_2L_2

MAIN WEB STRESSES (INCLINED CHORDS)

By an exactly similar analysis a very simple relation between the maximum moment about the moment center for any web member of a truss with inclined chords, and the maximum bending moment at a point of an equivalent beam, can be derived as follows:

Let

M_G = maximum E-50 live-load moment about moment center G of the forces to the left of the section for given web member; (U_2L_2, Fig. 4.)

v = distance in panels from G to end Lo (Fig. 4);

u = distance in panels from G to left end of the critical panel p considered;

x = distance in feet from the right end of critical panel to the neutral point of no stress;

z = lever arm of web member in feet;

M_b = maximum bending moment at L_2 for a span $OB = x + l_2$ in length, i.e., for $l_2 = bp$ as above (Fig. 4) and $l_1 = x$.

The value of x is obtained in the usual way either analytically or graphically. By equating to zero the expression for the moment about moment center G when a single load is in the critical panel, the neutral point is located and the following value for x is obtained:

$$x = \frac{l_2 v}{Nu - v} \qquad (5)^*$$

If preferred, a simple graphical construction as shown in Fig. 4 will give the value of x.*

The influence line for the moment M_G, by which stress in diagonal U_2L_2 of Fig. 4 is determined, is drawn in Fig. 5. As in the case of shear no wheels are found to left of O when maximum stress occurs, and it is evident that the positive area OCB of this influence line is exactly similar to the triangular bending-moment influence line for point L_2 of a span $OB = x + l_2$ in length. For this case, however, the ordinates at L_2 have the new values:

Moment about G, $L_2C = \frac{l_2 vp}{l} = \frac{l_2 v}{N}$

Bending moment at L_2 of OB, $L_2C = \frac{x l_2}{x + l_2}$

$$= \frac{l_2}{1 + \frac{l_2}{x}} = \frac{l_2}{1 + \frac{l_2 (Nu - v)}{l_2 v}} = \frac{l_2 v}{Nu}$$

The ratio of these ordinates is seen to be simply u, therefore to find M_G from the tabular value of M_b and then the main web stress:

$$M_G = u M_b \qquad (6)$$

$$\textit{main web stress } (U_2L_2) = \frac{M_G}{z} = \frac{u M_b}{z} \qquad (7)$$

Example 7. Compute the maximum E-60 live-load stress in diagonal U_2L_2 of a through truss of 7 panels at 28.57 ft. = 200 ft., the truss being 30 ft. deep at U_1, 34 ft. at U_2 and 36 ft. at U_3. Length $U_2L_2 = 44.4$ ft. $u = \frac{34}{2} = 17$; $v = 17 - 2 = 15$; $l_2 = bp = 4 \times 28.57 = 114.3$ ft.; $z = 18 \times \frac{34}{44.4} \times 28.57 = 394$ ft. Then, using eq. (5),

$$x = \frac{l_2 v}{Nu - v} = \frac{114.3 \times 15}{(7 \times 17) - 15} = 16.5 \textit{ ft.}$$

Find M_b from table for $l_1 = x = 16.5$ and $l_2 = 114.3$ by interpolation:

For $l_1 = 15$ and $l_2 = 110$,		2800
Add for l_1	$1.5 \times 180 =$	270
Add for l_2	$\frac{4.3}{10} \times 230 =$	100
	$M_b =$	3170

Then, by eq. (7), stress U_2L_2 for E-50 equals

$$\frac{u M_b}{z} = \frac{17 \times 3170}{394} = +137$$

and for E-60,

$$137 \times \tfrac{6}{5} = +164$$

Example 8. Compute the maximum E-60 live-load stress in the vertical post U_2L_2 of Ex. 7 (Fig. 4). For this member the moment center G is at the intersection of U_1U_2 and L_2L_3, therefore the values of u and v are not the same as in the preceding example although the critical panel remains the same (L_2L_3).

$u = \frac{34}{4} = 8.5$; $v = u - 2 = 8.5 - 2 = 6.5$; $l_2 = bp = 114.3$ ft. as before; $z = 8.5 \times 28.57 = 242.5$ ft. By eq. (5),

$$x = \frac{l_2 v}{Nu - v} = \frac{114.3 \times 6.5}{(7 \times 8.5) - 6.5} = 14.03 \textit{ ft}$$

Compute M_b from the table by interpolation:

For $l_1 = 15$ and $l_2 = 110$		2800
Add for l_2,	$\frac{4.3}{10} \times 212 =$	90
Subtract for l_1	$0.97 \times 172 = 170 -$	80
	$M_b =$	2720

Then, by eq. (7), stress U_2L_2 for E-50 equals

$$\frac{u M_b}{z} = \frac{8.5 \times 2720}{242.5} = 95.5$$

and for E-60,

$$95.5 \times \tfrac{6}{5} = -115$$

*See Marburg, "Framed Structures and Girders," Art. 138, p. 282 and Art. 194, p. 392.

Counter Stresses (Inclined Chords)

The influence line (Fig. 5) for moment about moment center G to give stresses in the diagonals of panel L_2L_3 (Fig. 4) indicates that the maximum counter stress L_2U_3, which occurs when the negative moment is maximum, is obtained when the engines enter from the left and cover segment AO. It is found that when the criterion for maximum is satisfied no wheels of Cooper's loadings will be in advance of O. Thus the triangular influence line ADO can be used exactly as in the preceding case, noting that the value u now becomes $u + 1$ for the distance in panels from moment center G to *forward* panel load at end of critical panel. Using the same notation as in the preceding case, and, in addition,

$x_c = p - x$ (compute x by eq. (5) or use graphic method);

z_c = lever arm of counter, in ft.;

$l_2' = ap = L_0L_2$ for panel L_2L_3 considered;

M_c = maximum bending moment (from table) at L_2 of span $AO = x_c + l_2'$, for $l_1 = x_c$ and $l_2 = l_2' = ap$.

Then by analogy with eq. (6) and (7),

$$(-)\ M_G = (u + 1)\ M_c \qquad (8)$$

$$\text{counter stress } (L_2U_3) = \frac{(-)\ M_G}{z_c} = \frac{(u+1)M_c}{z_c} \qquad (9)$$

Example 9. Compute the maximum E-60 live-load stress in counter L_2U_3 of Ex. 7 (Fig. 4). Length L_2U_3 = 45 ft.; $u = 17$ as before; $l_2' = ap = 2 \times 28.57 = 57.14$ ft.; $z_c = 17 \times \frac{36}{45} \times 28.57 = 388.5$ ft.

$$x_c = p - x = 28.57 - 16.5 = 12.07 \text{ ft.}$$

Compute M_c from table for $l_1 = 12.07$ and $l_2 = 57.14$ by interpolation as follows:

For $l_2 = 55$ ft. and $l_1 = 10$ ft.,		1005
Add for l_1	$2.07 \times 100 =$	207
Add for l_2	$\frac{2.14}{5} \times 90 =$	37
	$M_c =$	1249

Then by Eq. (9), stress L_2U_3 for E-50 equals

$$\frac{(u+1)\ M_c}{z_c} = \frac{18 \times 1249}{388.5} = +58$$

and for E-60,

$$58 \times \tfrac{6}{5} = +70$$

Maximum Chord Stresses

Whenever the moment center for a given chord member lies at or vertically in line with one of the loaded chord joints at the ends of the critical panel, the table can be used exactly as for the case of maximum bending moment in a beam to obtain the maximum moment desired. The maximum stress is then found as usual by dividing by the lever arm of the chord member.

Example 10. Compute the maximum E-60 live-load stresses in chords L_0L_2, L_2L_3 and U_1U_2 of Ex. 7 (Fig. 4). Length $U_1U_2 = 28.9$ ft.

For chord L_0L_2 (moment center U_1), $l_1 = 28.57$ ft., and $l_2 = 171.43$ ft. From the table, M is,

For $l_1 = 25$ and $l_2 = 160$,		6290
Add for l_1	$3.57 \times 250 =$	900
Add for l_2	$\frac{11.43}{15} \times 550 =$	420
	$M =$	7610

stress L_0L_2 for E-50 equals

$$\frac{7610}{30} = 254$$

and for E-60,

$$254 \times \tfrac{6}{5} = 304$$

For chord L_2L_3 (moment center U_2), $l_1 = 57.14$ ft., and $l_2 = 142.86$ ft. From the table, M is,

For $l_1 = 55$ and $l_2 = 140$,		11,580
Add for l_1	$2.14 \times 200 =$	430
Add for l_2	$\frac{2.86}{10} \times 745 =$	210
	$M =$	12,220

stress L_2L_3 for E-50 equals

$$\frac{12,220}{34} = 359$$

and for E-60,

$$359 \times \tfrac{6}{5} = 431$$

Since this stress L_2L_3 is the horizontal component of stress U_1U_2, we get,

$$\textit{stress } U_1U_2 = 431 \times \frac{28.9}{28.57} = 436$$

Engineering and Temporary Structures for the St. Louis Pageant

Theatrical engineering is a rather limited branch of the profession, the work of which consists largely in the design of special structures and machinery for movable stages, special scenic effects, etc. A class of work which may be included in this branch is the design of the temporary structures for the open-air historical pageant given

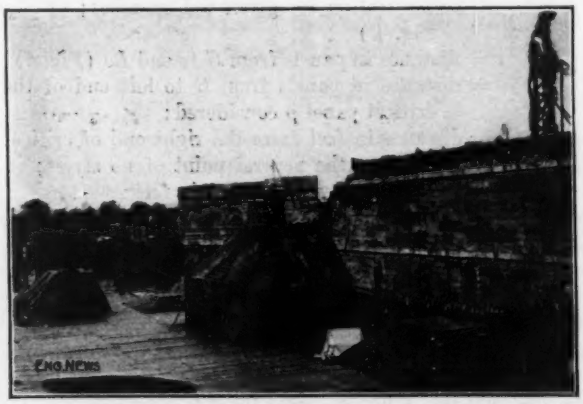

Fig. 1. The Stage and Accessories for the St. Louis Pageant

(At the rear is the 50-ft. sounding board, representing an Indian temple. On the stage are three of the "mounds" of the mound-builders, and behind these is the orchestra pit. The stage is built over a lagoon.)

recently at St. Louis, Mo., the conditions of use and the necessity of ample safety making it desirable to design these structures on engineering principles rather than by rule of thumb. The pageant was given on four days, before great crowds of spectators. The location was in Forest Park, at the lagoon beneath the hill occupied by the Art Gallery (the Art Building of the exhibition of 1904), and the seats for spectators were arranged upon the slope of this hill.

The design and construction of the several structures were under the direction of Nelson Cunliff, Superintendent of Construction of the Park Department, and the construction was done by employees of the park department. The work cost about $125,000 and after the closing of the pageant all the structures had to be removed and the park restored to its original condition. The work had to be planned, therefore, with a view to strength, safety and economy.

Timber Stage or Platform

The temporary stage on which the pageant scenes were enacted was built over the water of the lagoon, and was about 520 ft. long by 200 ft. wide. It is shown in Fig. 1. It was supported on piles spaced 7 ft. 9 in. by 8 ft., having a penetration of 7 to 14 ft. and calculated for 7-ton loads by the Engineering News formula. The piles were driven by an improvised piledriver scow with a gasoline engine and 1650-lb. ram (Engineering News, June 11). The same machine was used to pull the piles after the close of the pageant.

On the pile heads (over the 8-ft. spacing) were caps composed of pairs of 3x12-in. planks, across which were laid 2x8-in. joists, 16 in. apart, with a row of 1x3-in. cross bridging in each span (Fig. 2). Upon these was nailed the 2x10-in. floor planking, covered with roofing felt. The sides and rear were protected by hand rails. It was originally considered sufficient to design this for a load of 100 lb. per sq.ft., but Mr. Cunliff raised this to 250 lb. in view of the chances of concentrated loads, the vibration due to the movement of the crowds of performers, and the still heavier vibration due to the passage of artillery and cavalry in certain scenes. A roadway across the stage was covered with tan bark for these latter movements.

At each front corner of the stage was a tower or pylon 45 ft. high, and about 12 ft. square, having four concealed floors for switchboards, telephones (for the stage directors), and for singers. The stage manager considered that it would be necessary to design the floors to carry only a few people, but as a matter of fact it was found that 25 or more people would be on the several floors at one time.

Trussed Timber Wall

In order to render the voices of the performers and singers audible to the spectators a vertical wall or sounding board was erected along the back of the stage, and was painted to form an appropriate background. This is shown in Fig. 2. The central part, 165 ft. long, rose to a height of 40 ft. above the stage (or 50 ft. above the water), and the side section of about 55 ft. rose to a height of 35 ft. above the stage. These great flat surfaces were designed to withstand a wind pressure of 60 lb. per sq.ft., as high winds were liable to occur, and the supporting trusses were designed for 30 lb. wind pressure. At the back of the structure and supported by it were dressing rooms and gangways, so that ample provision had to be made for stresses due to vibration and irregular loading.

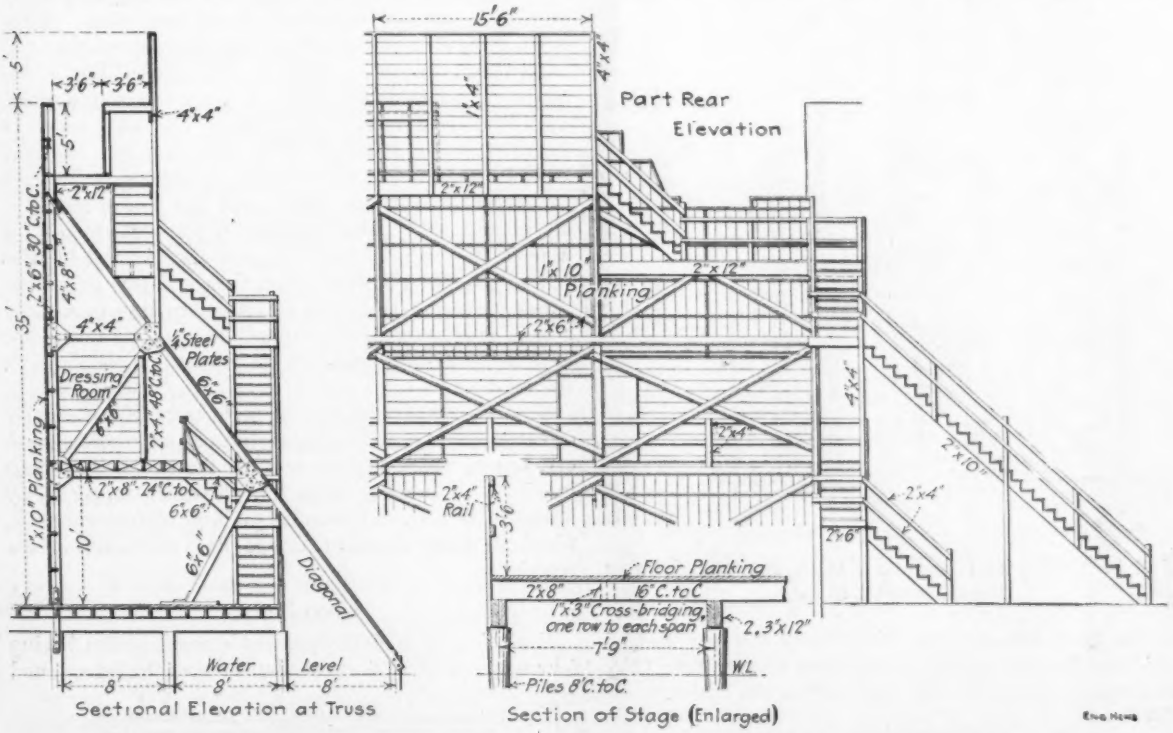

Fig. 2. The 50-Ft. Timber Wall or Sounding Board, with its Truss Supports

The central portion was supported by triangular trusses, resting on the floor, and each having the rear inclined member extended to an anchor pile beyond the stage (Fig. 2). These trusses were spaced 15½ ft. apart, and their inclined members were connected by horizontal struts and three sets of diagonal bracing. Between the vertical front posts were fitted horizontal sticks 2x6 in., 30 in. apart, to which were nailed the 1x10-in. planks forming the face of the sounding board. The truss members were put together with ¼-in. steel connection plates

punched with $\frac{11}{16}$-in. holes for bolts, the burrs being removed.

The side or wing portions of the sounding board were of similar construction, but the trusses carried no floors. They rested entirely on the stage, a 3x12-in. plank spiked

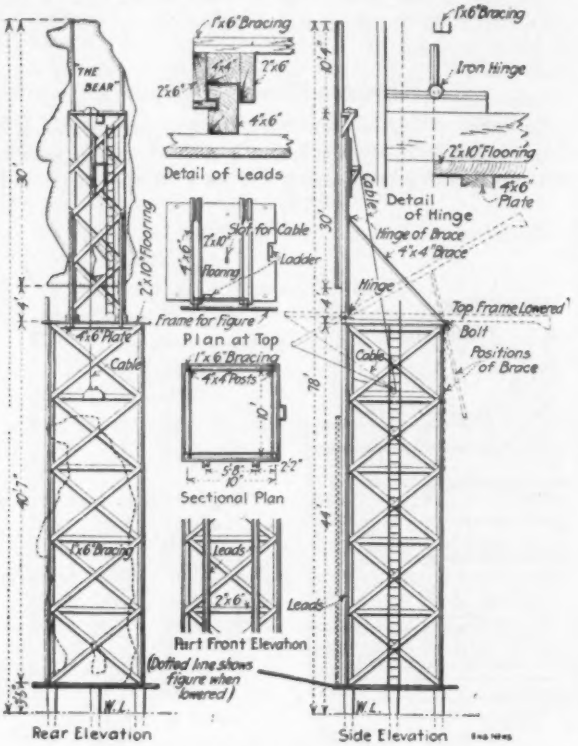

FIG. 3. TOWER AND MOVING FRAME FOR THE "GREAT BEAR" CONSTELLATION

to the joists serving as a sill to carry the rear post of the truss and its bottom strut. These trusses were 17½ ft. apart, connected in the same way as the others.

TIMBER TOWER FOR THE "GREAT BEAR"

One of the illuminated effects was the constellation of the Great Bear, appearing high above the background, the stars being represented by electric lights. The figure of the bear was 30 ft. high, and in its displayed position the top was 78 ft. above the water. As this illumination was to appear only during a part of the performance, the figure had to be made movable or disappearing, and at the same time the possible difficulties due to high winds had to be considered in the handling and supporting of the figure. The figure appears at the right in Fig. 1, and the method of support is shown in Fig. 3.

Behind the stage was built a tower 44 ft. high and 10 ft. square, having four posts 4x4 in., with struts and double bracing of 2x6-in. and 1x6-in. planks on each side. On the front side were two additional posts or leads, with side pieces spiked on to form grooves for the two vertical sticks or runners at the back of the sliding frame of the "bear."

Extending 34 ft. above the top of the tower was a framed panel hinged at the base, and having leads connecting with those on the face of the tower (and extending 10 ft. below the top of the tower to form a brace). This frame was supported by rear braces, and at its top was a pulley for the cable by which the figure was raised from the base of the tower.

The figure stood normally at the base of the tower. Before the performance it was raised to the full height of the frame, above the tower, and this frame was then revolved backward to a horizontal position. At the proper time it was swung up by block and tackle, the end of the rope being attached to the foot of the hinged frame.

TIMBER PYRAMIDS

The first scene of the pageant was in the days of the Indian mound-builders, and the mounds built by this race were represented by structures forming sections of truncated pyramids (vertical on the rear side). These were of timber framing covered with painted canvas.

The largest of these, shown in the center of Fig. 1, was 32x35 ft. on the base, and 25 ft. high, to a top platform 12x16 ft. surmounted by a temple. The posts were 4x4 in., with inclined corner sticks 2x10 in., and studding 2x4 in. In this largest structure an elevator was rigged for certain spectacular effects, and this was operated by block and tackle. After this part of the performance the mounds had to be removed from the scene, and for this purpose they were mounted on timber dollies or rollers. These structures had to be of ample strength to support a number of people, and to stand the vibration due to the performers moving about on the top and on the steps on the front slope.

To mask the entrance of the performers from each side of the stage there were wing sections of appropriate scenery, one of which appears between the two rear mounds in Fig. 1. These were large framed panels, supported by braces at the rear, and mounted on large casters with 4-in. wheels to enable the attendants to place and remove them readily.

WOOD BRIDGE

For the service of the pageant a wood bridge having four spans of 15 ft. 6 in. was built across the lagoon, and

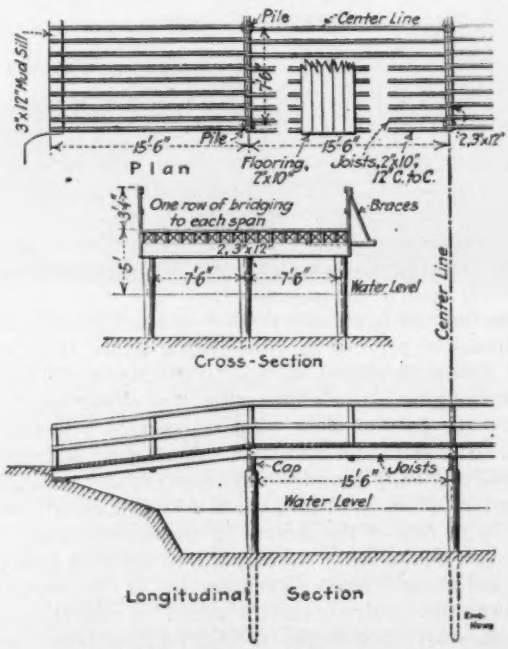

FIG. 4. TEMPORARY TIMBER BRIDGE

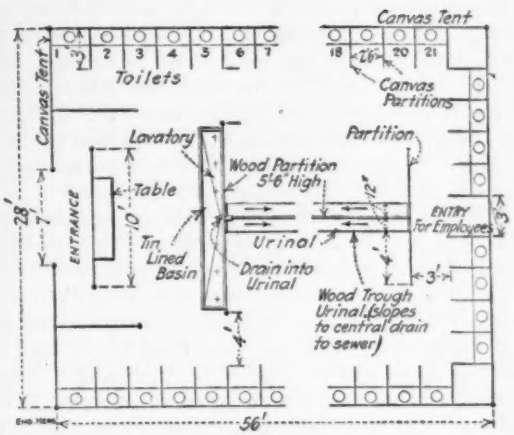

FIG. 5. TEMPORARY PUBLIC-COMFORT STATION IN TENT, ST. LOUIS PAGEANT

was designed for a live-load of 250 lb. per sq.ft. This bridge, Fig. 4, had three bents of three piles each, with caps composed of pairs of 3x12-in. planks. On these were the 2x10-in. joists, 12 in. c. to c., with a line of double bridging between them in the middle of each span. The shore ends of the joists rested on mudsills 3x12 in. The floor was of 2x10-in. planks, and uprights spiked to the outer joists carried the hand railing, the upright in the middle of the span having diagonal braces.

The bridge was built in 2½ days, at a cost of about $200. The materials used were as follows:

Piles (9)	15 ft. long
Floor beams and mud sills, 8 pieces, 3x12 in.	16 ft. long
Joists and flooring, 155 pieces, 2x10 in.	16 ft. long
Bridging, 10 pieces, 1x3 in.	16 ft. long
Hand railing, 28 pieces, 2x4 in.	16 ft. long
Nails, 20d	1 keg

PUBLIC-COMFORT STATIONS IN TENTS

Toilet accommodation for the performers and the crowds of spectators were provided in tents, a dry-pail system being used, as there were no sufficient sewer connections. The urinals, however, were connected to the park sewers. The pails were removed at night by the park department, and were emptied and cleaned at a city sewer about a mile from the site of the pageant.

There were two public-comfort stations (one for men and the other for women) in tents 28x56 ft., arranged as shown in Fig. 5. The arrangement of the women's tent was similar, but in the center were two additional rows of toilet rooms, set back to back, with a 3-ft. passageway between them for the use of the attendants.

For the performers there were four tents 14x21 ft., with a similar arrangement, except that the women's tents (two) had a single row of toilets in the center.

Temporary water mains were laid to serve a number of bubbling fountains and hydrants were provided for fire service.

The American River Irrigation District, to be formed under what is known as the Wright Irrigation District Act of California, has been recommended by a Citizens Investigating Committee headed by J. B. Wrangham, chairman, Fair Oaks, Calif. A report on the project has been made by Stephen E. Kieffer, Consulting Engineer, Mechanics Institute Building, San Francisco. The proposed district would have an area of 18,115 acres located between Sacramento and Folsom, on the north and west side of the American River. The source of water-supply would be the ditch of the existing North Fork Ditch Co. The system of this company includes 25 mi., to quote from Mr. Kieffer's report, "of well-constructed ditch and a system of pressure pipe lines. The ditch would be enlarged and cemented and the pipe lines rebuilt, enlarged and extended." The estimated cost of the "ultimate planned development" is placed by Mr. Kieffer at $687,000, or $37.90 per acre, but this does not include the purchase price of the North Fork Ditch Co. Excluding charges for water rights the estimated annual charge upon irrigated land for water tolls and taxes would be $2.65 in 1915, increasing to $4.59 in 1919, and then gradually increasing. The committee states in its report that adding the cost of water rights and physical properties, which, as we understand, it is proposed to purchase from the ditch company, the total cost of the project would be to $1,087,000, or $58.89 per acre. Taking everything into account, the annual charges for water tolls and taxes and for water rights would be $3.73 per acre in 1915, increasing to $5.11 in 1919. The reports of the committee named and of Mr. Kieffer, including an analysis of the Wright Irrigation District Act, were published as a supplement to "The Fair Oaks Citizen," of Fair Oaks, Calif., for Aug. 20, 1914. Mr. Kieffer informs us that the report was accepted by a mass meeting of the citizens of the district held on Sept. 5 and steps for the organization of the proposed district are to be taken.

Fire and Water Tests of a Metal-Lathe Wall*

A 2½-in. solid metal-lath wall of construction shown in the accompanying cut was erected in a fire-test house at Columbia University, New York City, and subjected to an average temperature of 1700° F., for 2½ hr., as measured by three thermo couples connected to a Le Chatlier pyrometer. At the end of this period a 1⅛-in. stream of cold water at hydrant pressure (25 to 30 lb.) was directed against the partition for 2½ min. Neither the fire nor the water did sufficient injury to the wall to destroy its stability or fire-resisting quality.

The partition wall tested was 14.5x9.5 ft. high, and the studding was of 1-in. channel-iron weighing 0.76 lb. per lin.ft. and set 12 in. c. to c. The lath was 24-gage expanded metal lath painted on both sides, and weighing 3¼ lb. per sq.yd. It was sewed to the studding with No. 18 annealed galvanized tie-wire.

The first, or scratch, coat of plastering was 1 part portland cement, $\frac{1}{16}$ hydrated lime and 2½ sand, by volume. About 1 lb. of long cattle hair per 1 cu.ft. of cement was used. Two similar coats, with the omission of the hair, were then applied; and finally a coat of 1:2½ mix was put on.

The heat developed a number of cracks in the exterior face of the wall within the first 10 min. of the test. No cracks were noted on the inside during the first 1½ hr., when four cracks averaging about 2 ft. in length appeared. After a total period of 2 hr. 40 min., the inner surface of the wall became crazed with innumerable hair cracks extending in all directions. The maximum opening was only $\frac{1}{16}$ in. deep.

The partition started to deflect inward almost immediately after the test was started; the maximum deflection was $4\frac{3}{16}$ in. After cooling the wall with water, the deflection was $2\frac{7}{16}$ in. The application of water washed away a large portion of the finish coat of plaster, and considerable of the second coat. No metal was exposed.

No fire, smoke or water penetrated the partition and after it had dried out, it was firm and gave a good ring when struck with a hammer.

*From a report of a fire and water test upon a fireproof partition, made at the Columbia Fire Testing Station, New York City, on July 17, for the Associated Metal Lath Manufacturers.

Methods and Equipment for Applying Lime Water at the Columbus Water-Purification Works

By Charles P. Hoover*

In the use of lime for water treatment at Columbus, Ohio, various methods for applying the lime water have been tried, and improved methods and apparatus have been adopted. This article, which is supplementary to one on "The Use of Lime in Water Purification," published by the present authors in Engineering News of 1914, outlines earlier experiences and describes present methods and apparatus employed at Columbus.

It may be explained in passing that the water of the Scioto River is treated with lime, soda ash and sulphate of alumina to soften and purify it, and after the various chemicals have been given an opportunity to react the water is passed through mechanical filters. This article is concerned only with the methods and apparatus used in applying the lime.

Methods of Applying Lime Water

The following methods of applying lime to water have received considerable attention:

(1) Treating the water with a saturated solution of lime water (60 grains CaO per gal.).

(2) A continuous feed of standard strength solution of milk of lime.

(3) Adding weighed amounts of lime at definite intervals of time.

Saturated Lime Water—When the Columbus plant was first started it was thought advisable to apply lime to the water as saturated lime water, for the following reasons:

(1) Lime water being a true solution could be more readily applied in uniform quantities than milk of lime.

(2) The feasibility of thoroughly mixing raw water with milk of lime in large quantities was questioned. It was thought that the raw water and the milk of lime would not be adequately mixed, resulting in a marked loss in softening efficiency, owing to the fact that the suspended particles of lime (calcium oxide) would become coated with precipitated carbonate of calcium and magnesium hydrate, thereby becoming inactive.

Adhering to this theory, the plant was equipped with lime saturators and an attempt was made to apply the lime as saturated lime water. After being pumped into the weir box of the head house, the water was divided. One portion passed over a weir, milk of lime was added and it was then passed into the lime saturators, designed to make a saturated lime water carrying about 50 grains $Ca(OH)_2$ in solution and about 15 grains in suspension in excess.

Fixed and adjustable weirs were provided, regulating the flow of raw water to the saturators from a minimum of 11% to a maximum of 24%. More than 50% saturation was never obtained. Considerable lime (Ca O) was lost in the sludge which collected in the bottom of the saturators. Sludge taken from these deposits contained as much as 10% CaO, hence, after a short time, the attempt to make saturated lime water was abandoned.

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Standard Solution of Milk of Lime—Since abandoning the procedure of treating with saturated lime water, milk of lime has been added to the raw water, either at the entrance of the saturators which are now used as mixing tanks or at the entrance of the baffled mixing tanks. It is fed automatically in proportion to the quantity of water pumped. This is accomplished by means of an automatic chemical feed regulator.

The method of handling lime in bags was abandoned in February, 1913, and an entirely new equipment was installed for storing and handling the material. In this new method of procedure, as now practiced at the Columbus water-softening and purification plant, crushed lime is elevated into storage bins, and from the storage bins the lime drops into automatic weighing scales, definite amounts of lime being discharged from the scales into the slacking tanks at predetermined intervals of time. (The storage bins and weighing apparatus are described in some detail further on.) The slacked lime is discharged from the slacking tanks into the chemical solution tanks below, and milk of lime of required strength (3 or 4% solution) is made by the addition of water. The paddles installed for the purpose of keeping the milk of lime thoroughly stirred have proven inadequate, and jets of compressed air have been supplemented at three points near the bottom of each solution tank. Tests made upon portions at 15-minute intervals, from the time the solution tank first begins to discharge until it is empty, show that the solution varies in strength from about 2 or 3% each side of the mean.

Adding Weighed Amounts of Lime at Definite Intervals of Time—At the St. Louis water-purification works, lime is weighed by automatic weighing scales into slacking tanks, and discharged from the slacking tanks directly into the water. This plan may very easily be adopted at Columbus by simply bypassing the present lime-solution tanks.

The advantages of this plan are:

(1) No chemical feed regulator is required other than the automatic weighing scales.

(2) No chemical-solution tanks are needed, thus the paddles and air necessary to keep the milk of lime in good suspension may be dispensed with.

But in order for this plan to work out successfully it is necessary that the quantity of water to be treated with lime be delivered to the plant at a uniform rate.

Piping Milk of Lime—Much trouble was experienced at Columbus in transporting the lime milk from the orifice box to the point of application to the water. Heavy deposits of lime formed in the pipes and stopped them up. This was overcome by connecting an ejector into the pipe just below the chemical feed regulator.

Hydrated vs. Quicklime—The work of sacking lime from cars proved to be a very disagreeable job, especially in hot weather, on account of the lime dust slacking on the sweaty hands and faces of the men. This slacking of lime dust often resulted in severe burns and sores. It was thought that the disagreeable feature attending the use of quicklime might be overcome by using hydrated lime in its place.

Several carload lots of hydrated lime packed in 40-lb. valve-type paper bags were received and used. This material was easily stored because the bags were square and could be closely packed, and as the lime had its affinity for water satisfied there was no trouble from swelling and

bursting of bags. The material could be kept indefinitely without losing strength because it packs into a dense mass, rendering the penetration of carbon dioxide very difficult. However, it did not prove economical or satisfactory to handle, and its use was abandoned for the following reasons: Hydrated lime costs more than quicklime. If the hydrated lime is shipped to the plant where it is to be used the consumer must pay freight on a large per cent. of water, aproximately 30%. It is very difficult to apply hydrated lime to water on a large scale. One of the disagreeable features of using hydrated lime in large quantities is that it "flies" badly, scattering dust through the plant. The dust gets into the eyes, noses and throats of the men handling it. Hydrated lime, according to Monfort, cannot be successfully fed through an orifice, and if fed into automatic scales there is trouble due to bridging. For railroad, industrial or small city water-purification plants, where small quantities of lime are used and where the lime must be stored for long periods of time, hydrated lime is to be recommended in preference to quicklime because it does not air slack and can be kept indefinitely without losing strength.

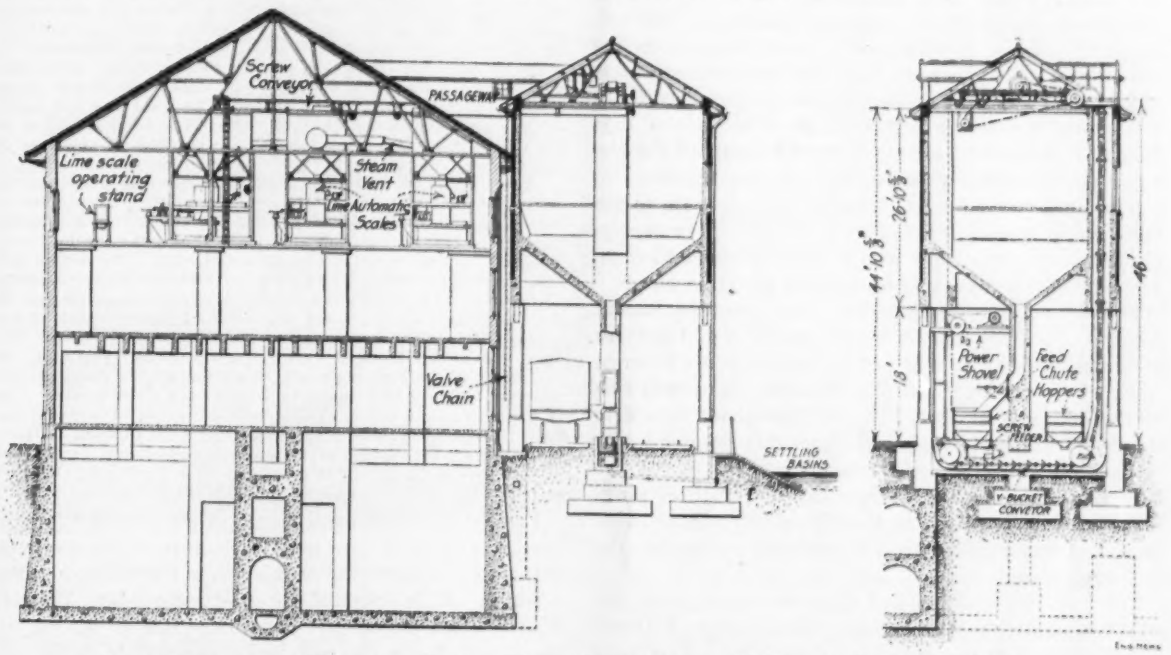
Purchase of Lime for Water Purification

The value of lime for water-purification purposes depends upon its percentage of water-soluble calcium oxide. The reactions already given show that it is the calcium oxide in the lime that absorbs the carbonic acid in the water and precipitates the magnesium. The percentage of inert material, such as carbonate of lime, cinders, unburned and overburned lime, magnesium, alumina and silica, increase or decrease in the same proportion as the calcium-oxide content increases or decreases, and the presence of this inert material detracts from the value of the lime because it increases the bulk, thus increasing the cost of handling and storing it. The inert material being insoluble in water, causes trouble by clogging the slacking tanks and orifice boxes and necessitates more frequent cleaning of the sedimentation basins.

In paying for lime the contractor should be paid a bonus when the calcium-oxide content of the lime exceeds the guarantee, and a penalty should be extracted when the percentage of the calcium oxide is below the guarantee.

Specifications for Lime Used at Columbus

For any carload of lime containing 88% of water-soluble calcium oxide, the city will pay to the contractor the price per ton stated in the proposal. It is hereby agreed that the city shall pay a bonus of 1½% of the contract price per ton for each 1%, by which the water-soluble calcium oxide in any carload lot delivered shall exceed 88%, and shall exact a penalty of 1½% of the contract price per ton for each one per cent. by which the water-soluble calcium oxide in any carload not delivered shall be less than 88%.



Lime-Storage and Handling Plant, Water-Purification Works of Columbus, Ohio

Analysis of Lime

Determination of Ca O Sugar Test:

Dissolve 1.0 gram of finely pulverized lime in 100 c.c. of a 10% sugar solution. Shake one hour on shaking machine. Filter through dry filter. Titrate 25 c.c. with N/10 H_2SO_4, using Phenolphthalein as indicator. The burette reading multiplied by 1.122 = % Cao. (The 10% sugar solution should be made with cool, freshly boiled distilled water.)

Lime-Storage Bins, Conveying and Weighing Apparatus

As has been explained, the lime used at the Columbus plant was at first handled and stored in canvas bags. Finding this unsatisfactory, the lime was bought in bulk in carload lots, bagged at the purification works and used shortly after bagging, the lime contractor varying his weekly deliveries to suit the demand as determined by the changes in the character of the water. Regulation of the

supply proving difficult, and the operations also proving troublesome and expensive, the writer and C. J. Clarke, engineer in the water-works department, were instructed to devise new means for handling the lime. Their plans and specifications were adopted, after having been checked by R. S. Jones, of Columbus, who suggested some changes. The storage-bin, conveying equipment and automatic weighing scales were described by the writer in the annual report of the Columbus Division of Water for 1913, from which the remainder of this article is reprinted.

STORAGE BIN—This consists (see sections of hopper and building) of a concrete hopper, 25½ ft. square, with bottom slopes of approximately 38 degrees with the horizontal, heavily reinforced to take the direct pull due to the weight of the lime and the horizontal thrust due to the bulging effect. The main weight is carried on four reinforced-concrete beams, supported in turn by eight columns with flared footings, which take bearings on the solid gravel under the track bed. The center column takes part of the load of the hopper and is cored inside with an 18-in. square opening used as a chute to reclaim lime from the storage bin and deliver it by means of the elevator and conveyor to the tanks in the headhouse.

The lime may be taken directly from the cars to the tanks without passing into the storage bin. The storage bin has a capacity of 220 tons of lime, or about 22 days' supply, which gives ample storage for any emergency.

CONVEYING EQUIPMENT—The conveying equipment consists of a continuous V-bucket conveyor and elevator with a capacity of 50 tons per hr., running in a concrete trough between the tracks and through chutes each side of the bin, so that it is inclosed throughout its entire length. The lime is discharged from this elevator into a 12-in. screw conveyor which extends into the roof of the head house and discharges into the top of three tanks which are supported on the third floor of the head house on angle columns and extend through the ceiling into the roof space above.

The V-bucket conveyor and the screw conveyor are operated by an 18-hp. Westinghouse direct-current, 220-volt motor, situated in the roof of the storage bin. The tanks are constructed of ¼-in. steel plate, are 8 ft. square, with hopper bottoms, and have a combined capacity of approximately 22 tons, or about two days' supply.

Lump lime, averaging about 2 in. in size, is fed from the tanks into automatic weighing scales, which automatically weighs the lime into the slacking tanks. The slaked lime discharges from the slacking tanks into the lime-solution tanks below. Milk lime, of required strength, is made by the addition of water. The milk of lime is kept well stirred by means of paddles and jets of compressed air and is measured into the water by a chemical-feed regulator. Later it is planned to pipe the slacked lime directly from the slacking tanks into the water, thus bypassing the lime-solution tanks and the chemical-feed regulator.

The writer is indebted to W. N. Goodman for the following description of the automatic scales.

AUTOMATIC SCALES—The three automatic scales are alike. Each is built on the equal balanced-beam principle. On knife edges at one end of the scale beam is suspended the weight hopper and at the other end of the beam, also on knife edges, is suspended the weight box or pan, in which are placed U. S. standard weights to the amount of 75 lb., when that quantity is desired to be weighed. If a 100- or a 150-lb. weight is required, then the actual weight desired to be discharged is placed in the weight box; or the excess of weight over 75 lb. can be added by a sliding counterpoise working on the graduated lever.

The lime is fed to the weigh hopper of the scale down a sloping chute in which is placed a reciprocating plate feeder to keep the lime from blocking. This feeder is in action only while the scale is filling. It is motor-driven by an electric motor, and as soon as the scale has received its load the motor automatically stops.

After being fed down the inlet chute the lime passes through a gate of the undercut type. When the weigh hopper has received four-fifths of its load the gate partially closes, the last one-fifth being dribbled into the hopper. When the exact amount has been received into the hopper, the gate closes and is locked by a toggle mechanism. The scale hopper holds the load until it is time to discharge it.

The time of discharge of the three scales is governed by a very ingenious electric clock device specially designed for this job. The scales are connected electrically to the clock and so arranged that one, two or three scales may be discharged as desired merely by throwing in the corresponding switches. Supposing Scale No. 1 is required to discharge 100 lb. every minute; it is set to weigh exactly 100 lb. and a minute disk is placed on the clock face. At every one minute interval the clock movement closes a switch which is connected to the scale by means of a solenoid; this solenoid discharges the scale by allowing the weigh hopper door to open. After discharging the load the hopper door closes again and locks itself. In doing so it opens up the inlet gate and automatically starts another weighing, which will be discharged at the right time. The clock can be set to weigh any number of discharges, from 60 per hr. down to 1 per hr.

Each scale is equipped with an automatic stop-counter device, so that when a certain quantity of lime is required to be weighed into the slacking tank the counter is set to the number of drafts required, and when that quantity has been weighed the scale will stop automatically. The scales are very accurate, much more so than any hand-weighing methods.

In order to get rid of the steam arising from the water in the slacking tanks, pipes are connected to a suction fan, which draws nearly all the steam away from the scales. To prevent dust and steam from clogging the operating levers of the scales, all of the levers are placed outside of the scale proper, which is inclosed in a heavy cast-iron dust-proof casting. All of the pins in the scales are made of phosphor bronze and the bearings in which these pins work are bronze bushed, so there is no chance for corrosion to affect accurate and continuous work. The clock device is arranged in a dust-proof, lock-up casing, with glass doors, thus preventing tampering.

UNLOADING LIME FROM CARS—A power shovel for unloading lime from cars into the hopper of the conveyor is located just under the storage bin and supported on the columns. It is operated by a separate 5-hp., 220-volt Westinghouse motor, and has unloaded a 40-ton car in about three hours, two men being necessary to do the unloading. The total contract price for the bin and all equipment complete was $17,580. Extras were $1393.

The new installation was put in service Feb. 5, 1913, and it has operated successfully from the start.

COST OF OPERATING—A cost system is kept at the plant and the cost of every job or operation is known. A comparison of the cost of unloading, sacking and dissolving chemicals during the year 1912, the year before the new equipment was installed, and the cost of handling chemicals during year 1913 is of interest.

In 1912, 5774 tons of chemicals were used and 28,166 hr. of labor are charged against the handling of this material or 4 hr. and 53 min. for each ton handled.

In 1913, 7234 tons of chemical were used and 24,357 hr. of labor are charged, or 3 hr. and 22 min. per ton.

This represents a saving of 1 hr. and 31 min. on each ton of chemical handled. At the present time the labor cost of handling chemicals amounts to approximately 36c. per hour, so that the saving of 1 hr. and 31 min. is equivalent to approximately 55c. per ton.

Figured on this basis the saving effected during the year 1913 by the introduction of this new equipment amounted to $3979.

Methods of Construction of the Grand Mere Hydro-Electric Plant, Quebec

One of the largest hydro-electric plants in Canada is now nearing completion at Grand Mere, Quebec, 90 miles northeast of Montreal. At this point, the St. Maurice River which drains an area of some 17,000 sq.mi. lying

FIG. 1. THE ROCKY ISLAND WHICH GAVE GRAND MERE FALLS ITS NAME

north of the St. Lawrence, crosses a barrier of hard Laurentian rock and falls about 45 ft.

The Laurentide Co. has for years had in operation at this point one of the largest pulp and paper manufacturing plants in Canada, utilizing, however, only a part of the available power. Two years ago, the company determined to proceed with the work of power development at this point on a large scale, and plans for the work were prepared by Geo. F. Hardy, Consulting Engineer, 309 Broadway, New York. On Jan. 16, 1913, a contract for the construction of the entire work was made with the H. E. Talbott Co., Engineers and Contractors of Dayton, Ohio.

At Grand Mere Falls, the St. Maurice River is divided into two channels by a large island of hard rock covered with a heavy growth of trees.

On the western channel the original power plant and paper mill were constructed. In the project for utilizing the entire flow of the river, it was necessary to cut this rocky island down to water level to obtain a sufficient length of spillway for controlling the water level above the falls in the flood season.

It was a detached pinnacle of this island whose rugged profile gave Grand Mere its name, as may be understood by reference to Fig. 1, showing a winter view of the "Grandmother." While this ancient landmark had also to be removed in building the new power plant, the directors of the Laurentide Co. desired that it should be preserved, and the contractor was required to take it down piece by piece and reërect it on a pedestal near the company's office. The total mass moved represented five or six hundred tons of rock.

While the natural fall was about 45 ft., the dam now under construction will so raise the level of the water above the falls as to give a total head of 76 ft. The still water, navigable by motor boats, will extend about 75 miles upstream to La Tuque.

The advantage to the power plant of the great storage thus created for carrying peak loads will be obvious. It may be noted in addition, that the Provincial Government of Quebec has made plans for transforming a labyrinth of lakes on the upper reaches of the St. Maurice into great storage reservoirs, which will enable the spring floods to be impounded and released during low-water periods.

The designs for the hydro-electric plant at Grand Mere provide for the development of 180,000 hp. by nine turbine-generator units of 20,000 hp. each. These turbine-generators are to be located in a power house which will form a barrier across the west channel of the river.

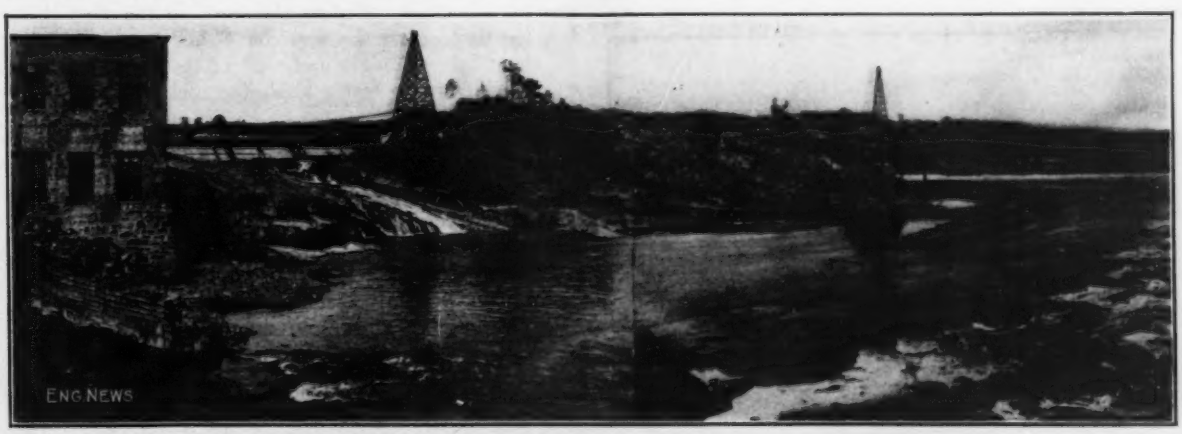


FIG. 2. BEGINNING WORK AT GRAND MERE FALLS, JULY 20, 1913.

(Old paper mill at left. Upper coffer-dam completed on top of old paper-mill dam. Work started on coffer-dam across tail race.)

The east channel of the river is to be closed by a concrete spillway dam which will extend across the island.

The construction work had to be carried out without interrupting the operation of the present power plant and paper mills located close to the west bank of the river. This was not wholly disadvantageous, however, since the large proportion of the river's flow diverted through the turbines of the present paper mill, made so much less water to be taken care of in construction.

To lay dry the power-house site, the water was shut off from above by a low coffer-dam on top of the paper company's old wooden crib dam. This was comparatively easy. Then a coffer-dam about 600 ft. long was carried across the tailrace in an average depth of some 20 ft. of water. This dam was made up of wooden cribs with 12x20-ft. pockets filled with stone, the outside covered with sheet piling and canvased to make it water-tight. The rock bottom on which this coffer-dam was placed was very irregular and was covered with a deep deposit of bark, logs, gravel and boulders, which had to be dredged out before sinking the cribs.

As noted above, the contract for the work was signed on Jan. 16, 1913. The early months of the year were spent by the contractor in getting his force and plant onto the ground and organized. The coffer-dams could not be built until after the spring floods in May, when the melting snow pours into the upper reaches of the river.

FIG. 4. DRAFT TUBES COMPLETED AND ROCK EXCAVATION IN TAIL RACE IN PROGRESS, NOVEMBER, 1913

Between that time and the latter part of August, however, the coffer-dams were completed and pumped out. By the end of December, the rock excavation had been completed over the whole power-house area, about 400x160 ft., and in the tailrace below the power-house area, as shown in the accompanying figure. The draft-tube forms had been placed and the concrete had been poured for the entire lower portion of the power house and the section of dam adjoining, bringing the structure to the elevation of the scroll case and above the normal level of water in the tailrace. The pumping plant and lower coffer-dam had also been removed.

Work on concrete laying could not be resumed in the spring till after the flood season in May. Fig. 5 shows the

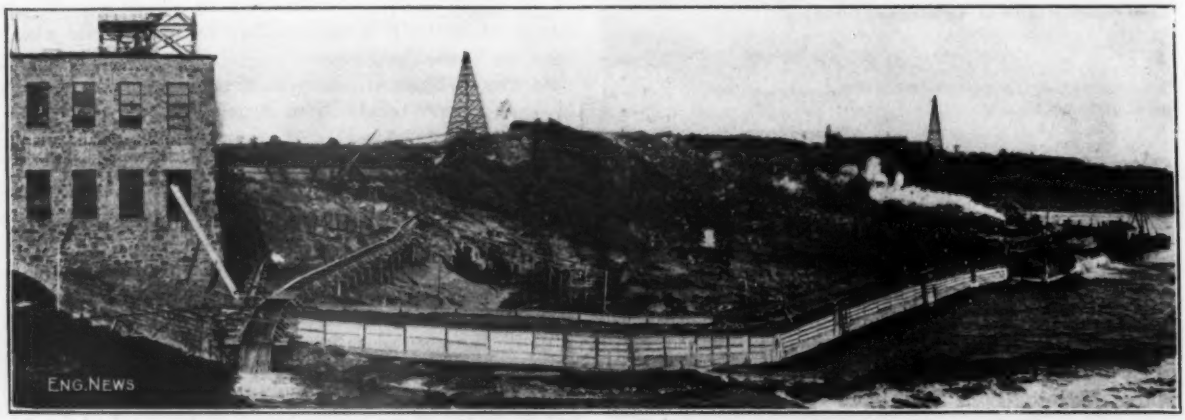


FIG. 3. TAIL RACE COFFER-DAM, COMPLETED AND PUMPED OUT, AUGUST 15, 1913

flood pouring over the power-house foundation on May 27, 1914. Fig. 6 shows the power-house foundation on June 11, after most of the flood had subsided.

Work was now pushed with the utmost rapidity. Hoisting towers and concrete distributing spouts were erected and the placing of forms and of reinforcement previously made ready and the pouring of concrete went on night and day. Fig. 7 is reproduced from a photograph of the power-house work taken on July 24. A month later, the steel frame of the power house was nearly completed and the concrete had been carried up to the floor level on the generator room, while the work of concreting the partitions between the gate openings was far advanced. Besides the work on the west channel, the dam across the east chanel had been completed for about half its length and most of the island had been excavated down to water level, the rock removed being used for concrete.

It will be of interest to note the plant, methods and organization by which the work has been carried forward with such rapidity. The accompanying general plan of the work, Fig. 8, will assist in making the operation clear.

In the first place, it is well to emphasize that the problem of chief magnitude on such a work is the problem of rapid and economical conveying and placing of material. The entire work involves the excavation of 145,000 cu.yd. of rock and 245,000 cu.yd. of earth, placing 170,000 cu.yd. of concrete with 1000 tons of reinforcing steel and erecting 2000 tons of structural steel. The lumber, cement and steel which have to be brought to the work aggregate over 2000 carloads.

The river at the falls flows in a narrow gorge with steep banks, and available room on the west side was already occupied by the paper company's plant. Material had to be received and stored on the banks of the river therefore high above the site where it was to be finally used. The cableway system was adopted to transport the material from this point to its place in the works, and it is difficult to see how any other system could have compared with it for economy or speed.

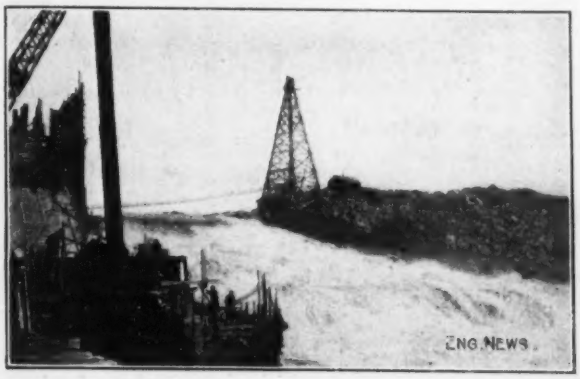


FIG. 5. SPRING FLOOD GOING OVER COMPLETED LOWER SECTION OF POWER HOUSE, MAY 27, 1914

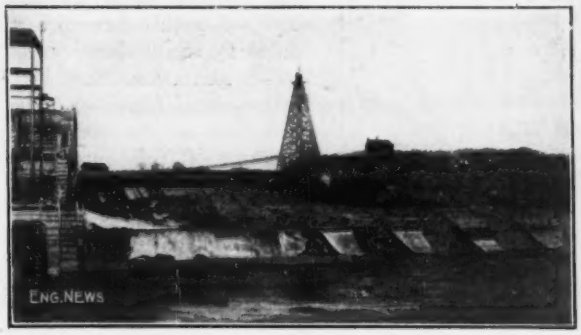


FIG. 6. LOWER PART OF POWER HOUSE AFTER PARTIAL SUBSIDENCE OF FLOOD, JUNE 11, 1914
(Inclines are the lower parts of the penstocks above the turbines.)

Sidings were built from the railway to the site on both sides of the river, one on the west side reached a sand deposit on the west bank below the falls from which sand for the work was obtained. The sand was loaded on railway cars by a clam-shell bucket handled by a locomotive crane. A clam-shell bucket and crane was also used to transfer the sand from the cars to storage bins, from which it is drawn for use as required.

On the immediate site of the work, the materials were hoisted and conveyed by four Lidgerwood cableways. One of 7 tons capacity and 1650-ft. span extends from the main concrete mixing plant over the power house and part of the dam, and is used chiefly for transporting concrete from the main mixing plant to the work. A smaller cableway of 3 tons capacity and 600-ft. span, on the west side of the river, carries materials for concrete to an auxiliary mixing plant on the roof of the paper-mill building on the west bank of the river close to the power-house site from which mixer the concrete is chuted where desired. Another 7-ton cableway of 1125-ft. span is stretched over the island. Skips of rock loaded by the excavating force on the island are carried on cars running on transverse tracks to a point beneath the cableway, and are then hoisted by the cableway, carried to the east bank and dumped on an inclined platform from which the rock slides into the crushers. A fourth cableway will handle concrete for the completion of the spillway over the east channel.

All but one of these cableways are operated by electric motors. Current for these and other motors on the work and for lighting the entire plant is supplied from the hydro-electric plant at Shawinigan Falls, four miles below on the St. Maurice River. The 50,000-volt current is received at Grand Mere in a transformer station where it is stepped down to 2240 volts by a bank of three 1000-kv.-a. transformers. Part of this 2240-volt current goes to a bank of three 100-kw. transformers which reduce it to 370 volts at which pressure it goes to a rotary converter for reduction to 600-volt direct-current for operting d.c. motors.

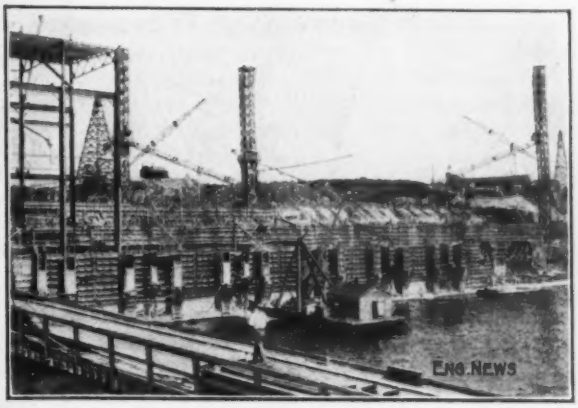


FIG. 7. PROGRESS OF CONCRETING AND STEEL SUPERSTRUCTURE ERECTION, JULY 24, 1914

Another part goes to three 75-kw. transformers which deliver 450-volt current for a.c. motors. The current for lighting passes through a 25-kw. transformer and is delivered at 230-115 volts.

The concrete bucket used on the long span cableway is shown in Fig. 9. The bucket is dumped by letting the two overlapping hinged leaves which form the bottom of the bucket swing apart. These leaves are held closed by the tension on the ropes by which the bucket is traversed on the cable, and by slacking on these ropes the cableway operator can dump the bucket at any point.

This system gives very rapid operation, and the bucket empties itself clean. With the bucket traversing a distance of 1100 ft., 187 buckets of 2.4 cu.yd. each were poured in a ten-hour shift.

For distributing concrete in the power-house construction, extensive use is made of hoisting towers with chutes and gates, as may be seen in the accompanying figures. Small electric trolley hopper cars are used for carrying the concrete from the hopper into which the cableway deposits it to the foot of the hoisting towers. Portable mixers are used on parts of the work not easily reached by the cableways. During the month of July about 21,000 cu.yd. of concrete were placed in the work.

In order that the rate of progress of the work might be carefully watched, a large diagram was plotted at the outset with lines showing the expected rate of progress on ex-

cavation, concrete laying, steel erection, and other principal items of work. This diagram is posted on the wall of the main office and upon it is plotted daily the amount of work accomplished. By comparison of the lines of expected and of actual progress, it is seen at a glance whether the work is proceeding faster or slower than is necessary to reach completion at the time originally planned. Daily reports are also filed, showing the output of each principal piece of plant, bucket of concrete handled, skips of rock transported, cars of sand delivered, etc.; also the hours of time during each of the machines was shut down, with the reason why the shutdown was necessary.

The main stone-crushing plant, to which the stone excavated from the island is delivered, consists of a large gyratory crusher with a small reciprocating crusher taking care of oversize pieces refused by the screen below the main crusher. Belt conveyors are used for carrying the broken stone and also for the bags of cement from the cement storehouse (15,000 bbl. capacity) to the mixer. A crusher is operated in the sand and gravel pit to crush cobbles and stones rejected by the screens through which the gravel is passed.

A carpenter shop, with band-saw, edger and other wood-working tools, was installed to carry out the form work; and to facilitate the laying out of the large and complicated forms necessary for the draft tubes, scroll cases, etc., a large level from table was built outdoors. The form work, of course, was done in advance so that as fast as the concrete was carried up, the forms were ready for setting.

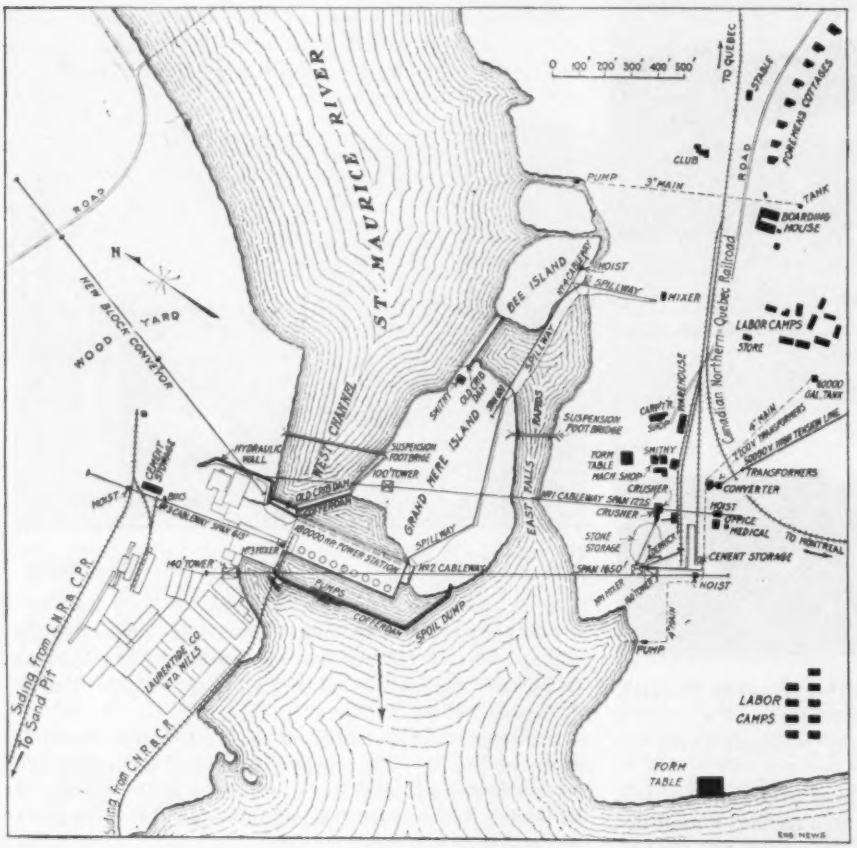


FIG. 8. GENERAL PLAN OF WORKS FOR CONSTRUCTING GRAND MERE HYDRO-ELECTRIC PLANT

Besides the work on the dam and power-house construction, a large tract of land next the river bank above the dam had to be raised some 12 to 15 ft. to bring it above high-water level when the dam is completed. This tract is used by the paper company for storing its year's supply of pulp-wood. It may be explained that the wood used for pulp is floated down the St. Maurice River from various lumbering operations on the head waters. Most of this wood comes down the river during the season of high water in the spring, and is cut into 2-ft. lengths, barked and put into storage to be used as needed. Two lofty steel towers, 180 ft. high, carry by light suspension members, a latticed truss, 600 ft. long. There is also a head tower 90 ft. high and an inclined truss 600 ft. long. These trusses carry an endless-chain conveyor, which transports the barked pieces of pulp wood and drops them on the storage pile.

This structure was erected last winter by the Talbot Co., which also raised the level of the wood-storage yard around these towers, bringing in for that purpose some 200,000 cu.yd. of earth on dump cars loaded by steam shovel.

The contractors have had, at times, a force of some 1100 men on the work, and the care of this force was as important a feature in securing rapid and efficient work as the provision of efficient machinery. Nearly all the foremen and even some of the workmen have been employed more or less continuously by the contracting company on various construction jobs since 1898.

As is usual on large construction operations, the working force is made up of a mixture of many nationalities, mostly brought in from outside. The local French Canadians were little used to construction work of this sort, and comparatively few were employed. A resident physician was constantly on the work and gave a careful physical examination to every applicant for employment. A considerable number, found to be infected with dangerous or infectious disease, were rejected and only those were accepted who were found physically fit for their jobs. The physician was also on hand to care for those hurt by accident or attacked by disease.

The water of the St. Maurice River is polluted by drainage from settlements above; and cases of typhoid in the locality are common. The entire working force, therefore, was supplied with water carted from large springs in the vicinity. To reduce the risk of accident to water boys

FIG. 9. BOTTOM DUMPING BUCKET FOR CARRYING CONCRETE

on the power-house work, the spring water was piped to several drinking fountains.

There being no suitable housing accommodations in the village of Grand Mere for the working force, a workmen's camp was built on the east side of the river. Fig. 10 shows a street in a section of this camp for the foreign workmen. About 40 of these bunk houses were built, and a system of discipline was put in force to keep the camps in sanitary condition, occupants of the camps who did not keep their houses clean or who did not use the sanitary closets provided for them, being fined.

For the foremen and English-speaking workmen, a boarding house was built for those without families and a row of neat cottages was erected which were rented to married men. Adjoining the boarding house was erected

FIG. 10. WORKMEN'S CAMP AT GRAND MERE FALLS

a bath house with showers and tubs for the free use of all employees. A club house was also built and equipped with pool tables, cigar stand, reading room and a barber shop. A nominal charge of 50c. per month was made for all club privileges.

These various provisions were effective in attracting to and retaining on the work an efficient force of contented employees.

In the organization of the H. E. Talbott Co., by which this work has been carried forward, H. E. Talbott, Jr., is general manager, and has resided at Grand Mere in general charge of all operations.

The progress made on the work this season has been so rapid that the entire plant would probably have been substantially completed by Jan. 1. The sudden financial stringency due to the European war, however, has made necessary a temporary curtailment of work, and, therefore, the date of completion is uncertain.

Snow Removal by Melting with Artificial Heat

By S. Whinery*

The opinion is quite general among engineers and others that, while theoretically it should be possible to melt snow on the streets by artificial heat at a reasonable cost, the method is impracticable and uneconomical in actual practice. Such experiments as have been made seem to confirm this conclusion. But the thoughtful enquirer is likely to reason that where a process appears to be practicable and economical in theory, failure to secure satisfactory results in practice may be due to a lack of knowledge or skill in applying it, and that the whole subject may be worth further investigation. The fact that, in burning, 1 lb. of coal gives off sufficient heat to melt from 70 to 90 lb. of snow, looks attractive at first thought to one who is not familiar with the difficulties of converting heat into useful work.

Snow removal in our Northern cities is one of the important municipal problems that has not yet been satisfactorily solved, though it has attracted much attention and has been the subject of no little unintelligent inventive skill. Many schemes and devices for disposing of snow by melting have been proposed and a number of them tried, only to prove failures because the basic scientific principles involved and their practical application were unknown or disregarded by the inventors.

There is not much available literature on the subject, and it may be worth while to review the scientific and practical elements of the problem, which are not so obstruse and complicated as those who have not investigated them are likely to imagine. The purpose of this article is to do this briefly, using for illustration a project for melting snow by the application to it of water, taken from the fire-hydrants, heated to a temperature just below the boiling point in an ordinary steam boiler and applied to the snow on the street by means of a hose and nozzle.

Assume that a standard 60-hp. portable boiler is used; i.e., a boiler capable of evaporating 30 lb. of water per hp. per hr., from a feed-water temperature of 100° F. to steam at a gage pressure of 70 lb., equivalent to about 29½ lb. from a feed-water temperature of 50° F. The quantity of water evaporated in an 8-hr. day would be $29.5 \times 60 \times 8 = 14{,}160$ lb. To convert 1 lb. of water into steam under the conditions named, requires, we know, the absorption of about 1165 B.t.u. and the quantity of heat necessary to so convert 14,160 lb. of water is

$$14{,}160 \times 1165 = 16{,}496{,}400 \text{ } B.t.u.$$

The quantity of heat required to melt 1 lb. of snow from a temperature of 20° F. is:

	B.t.u.
To raise the temperature to 32° =	12
Heat absorbed in fusion	142
Total	154

*Consulting Engineer, 95 Liberty St., New York City.

If the snow weighs 8⅓ lb. per cu.ft., the net quantity of heat required to melt 1 cu.ft. of snow would be:

$$154 \times 8\tfrac{1}{3} = 1283 \text{ B.t.u.}$$

But a part of the heat contained in the hot water would be lost in passing through the discharge hose, and in its application to the snow. If we assume that only two-thirds of the heat leaving the boiler could be made actually available for melting snow then the gross quantity of heat necessary to melt 1 cu.ft. of snow would be 1925 B.t.u., and the 8-hr. product of heat from the boiler should melt

$$\frac{16{,}496{,}400}{1925} = 8469 \text{ cu.ft.} = 317 \text{ cu.yd. of snow}$$

To heat 1 lb. of water from 50° F. (the assumed temperature of the hydrant water) up to a temperature of 210° requires 210° — 50° = 160 B.t.u., and since the boiler is capable of developing 16,496,400 B.t.u. per 8-hr. day, the quantity of water so heated would be;

$$\frac{16{,}496{,}400}{160} = 103{,}102 \text{ lb.} = 12{,}363 \text{ gal.}$$

What would be the cost?

We may safely estimate that in a portable locomotive-type boiler of 60 hp. capacity, 1 lb. of anthracite coal would evaporate 6 lb. of water, and as the evaporating capacity of the boiler is 14,160 lb. per 8-hr. day, the quantity of coal required would be

$$\frac{14{,}160}{6} = 2360 \text{ lb.} = 1.18 \text{ tons}$$

The complete plant necessary would be the portable boiler equipped with a gasoline engine to propel it on the street, sufficient hose to connect the boiler to a fire-hydrant, and a short discharge hose and nozzle.

As the pressure would be that in the water mains only, a cheap second-hand boiler could be used, and condemned fire hose would answer the purpose. The cost of the plant would probably not exceed:

One second-hand 60-hp. portable boiler	$750.00
Hose, nozzle and connections	300.00
Gasoline engine attached to boiler truck	250.00
Total	$1300.00
The "fixed" charges on the plant would be:	
Interest, depreciation and repairs, say 12½%	$162.50
Storage through summer season, say	15.00
Total	$177.50
If we assume that the plant could be used only 48 hr. per year = six 8-hr. days, these fixed charges would amount to per day	29.58
The total operating expenses per day would be about:	
Fixed charges	$29.58
1.2 tons coal delivered at $5.50	6.60
One fireman and engineer	3.00
One hoseman	3.00
One helper	2.50
Miscellaneous	2.00
Total	$46.68
And if 317 cu.yd. of snow were melted, the cost per cu.yd. would be	14.73c.
To cover contingencies, add 10%	1.47c.
Total per cu.yd.	16.20c.

The cost of hydrant water used is not charged in the account; in cities, like New York, having an abundant gravity supply during the winter season this item may be neglected.

The above statements and figures seem to be conservative on the side of safety, and, if so, the result ought to be attainable in practice. The figures seem sufficiently promising to warrant a fair trial of the project under working conditions.

We have, in the above, figured on melting all the snow on the street. It is probable, however, that more or less unmelted, or partly melted snow would be carried into the sewers with the current of water, thus tending to reduce the cost.

Recent experience in New York City seems to favor the method of disposing of snow by collecting and forcing it into the sewer-inlets and manholes by the use of a jet of cold hydrant water. By the hot-water method, no handling of the snow would be necessary. It would be melted as it lies on the street, and the resulting water would flow into the sewer inlets. There would probably be no question of the capacity of the sewers to handle all the water produced.

It is not intended to here discuss the probable merits or demerits of artificial snow melting, nor the practical difficulties and objections to be encountered. The purpose is only to outline the technical problems involved, for the use of practical men or inventors who may wish to give the matter further consideration.

The hot-water project was taken for illustration not only because it includes most of the technical elements involved, but because water is a good absorbent and conveyor of heat, and by its rapid penetration into the snow should transmit its heat to the snow with comparatively little loss. The plant used for illustration is crude, for it is to be remembered that in steam boilers only from 50 to 80% of the heat yielded by the fuel is actually taken up by the water. It is quite possible that a more efficient type of heater for the purpose could be devised.

At first thought, it would seem that a project for the application of the heat from the coal directly to the snow would be more economical and less complicated, but as this seems to involve the application of the heat to the surface only of the snow, the heat losses would be much greater than from the penetrating hot water.

Concrete Steps and Retaining Wall

A recent feature of park construction work at St. Louis is a long flight of steps on the slope of Government Hill, in Forest Park. It is about 145 ft. long, with a total rise of 25 ft., the steps being interrupted by two platforms. It was designed originally as a monolithic structure throughout, but Nelson Cunliff, Superintendent of Construction of the Park Department, thought that this would result in unsightly cracks, and that continuous expansion and contraction movements might result in the entire structure shifting downhill.

The design was therefore modified by putting an expansion joint through each platform, and designing each section as a beam with three pier supports. This is shown by the longitudinal section in Fig. 1. The middle pier forms an anchor, so that expansion and contraction movements take place in both directions from it. There is no longitudinal joint, but the steps are divided into two sections by a central turfed space. The steps are of rather unusual shape, 15½-in. tread and only 4-in. rise, so that it will be easy to wheel baby carriages up and down the steps. Each step has a pitch of ¼ in.

The reinforcement in the beam along each side of the steps consisted of four (or three) longitudinal bars at the bottom, three (or two) of these being bent up to come in the top of the beam at the piers, as shown in Fig. 2.

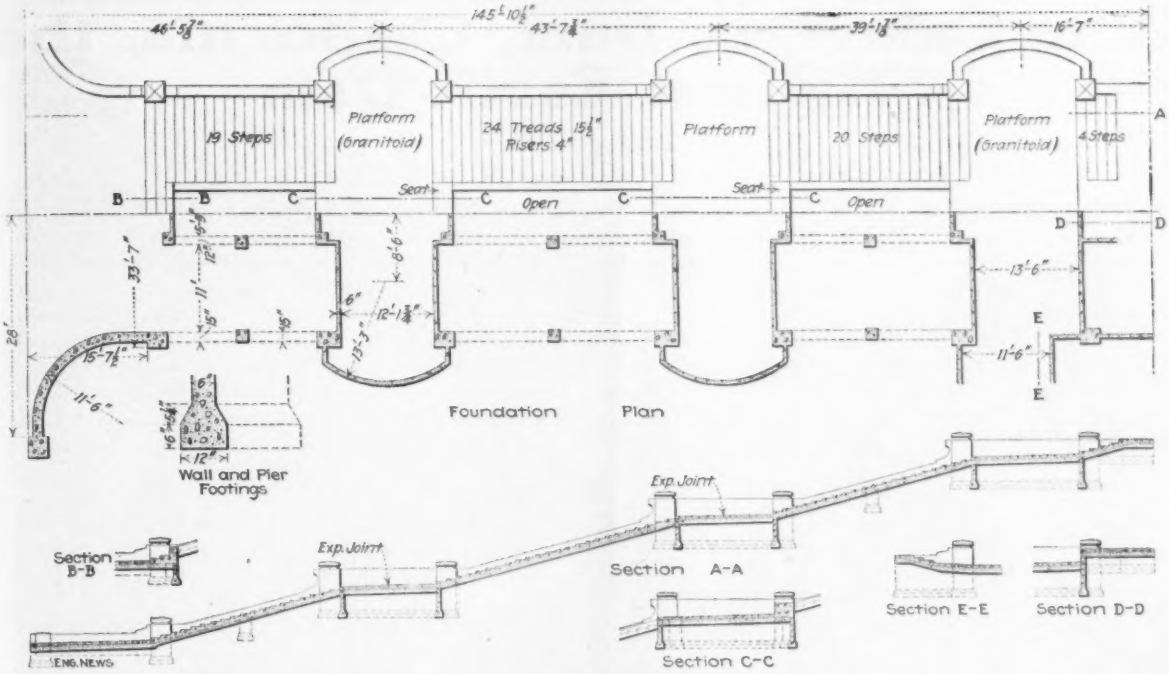


FIG. 1. PLAN AND CROSS-SECTION OF CONCRETE STAIRWAY ON THE SLOPE OF GOVERNMENT HILL IN FOREST PARK, ST. LOUIS, MO.

The structure is divided into sections by transverse expansion joints, and each section is anchored in position by a transverse pier at the middle.

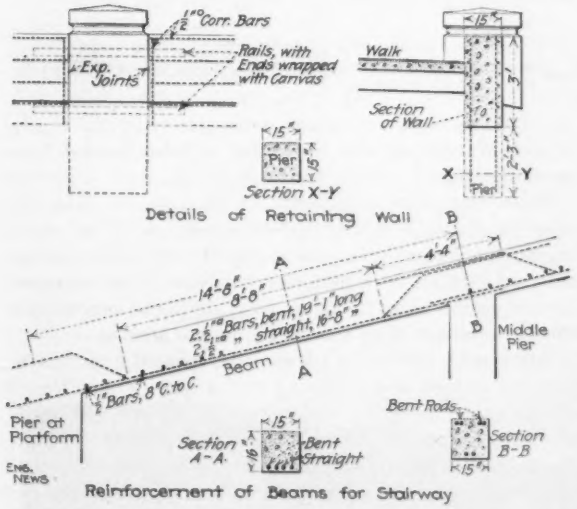


FIG. 2. DETAILS OF LOW RETAINING WALL AND THE REINFORCEMENT OF THE BEAMS OF THE STAIRWAY

Across the bottom bars were laid ½-in. transverse bars spaced 8 in. c. to c. Over the transverse bars were laid longitudinal bars 2 ft. c. to c. to prevent surface cracking. All bars were embedded at least 1 in. in the concrete.

The concrete is made with 1½-in. stone, the mixture being 1:2:4, and a granolithic surface is given to the steps. Wood forms were used. The construction was done by the park department force.

From the top platform of the flight of steps a concrete walk, at *E*, Fig. 1, will extend along the top of the slope of the hill in front of a pavilion. This will be supported by a retaining wall, which forms also a low parapet and has piers at intervals of 9 ft. 9 in. and 10 ft. 6 in. The wall is 13 in. thick and 3 ft. deep, or 5 ft. 3 in. deep at the piers. In front of the entrance to the building the walk is widened, and there the wall is made 5 ft. deep (7 ft. 3 in. at the piers). At each third pier (30 ft. c. to c.) the wall has an expansion joint on each side of the pier, made as shown in Fig. 2. In the pier are embedded old rails with the ends projecting to be built into the wall, these ends being wrapped with canvas to form a slip joint.

A Panama Canal Veteran Dredge Retired—The seagoing suction dredge "Culebra" has been retired from service, moored alongside the wharf at Paraiso, Panama, and dismantled. The retirement of the "Culebra" follows the practical completion of the work it is best suited to do, in the Pacific entrance and at the lake level. Its sister ship, the "Caribbean," now at work in the Atlantic entrance, will be able, it is thought, to handle the maintenance work of removing silt, in both entrances. The remainder of the heavy work in the Pacific entrance will be done by ladder, dipper and pipeline suction dredges. Construction work in the Atlantic entrance was completed in December, 1913, and subsequent work has been confined to the removal of silt.

The "Culebra" was built by the Maryland Steel Co., and sailed from its yards at Sparrows Point on Oct. 9, 1907, for Balboa, by way of the Strait of Magellan. The vessel arrived at Balboa on Dec. 28, and was placed in commission on Jan. 21, 1908. It worked in the Pacific entrance channel and in the slips alongside the wharves at the Pacific terminus until Jan. 20, 1914, when it was transferred to the Gatun Lake level and put at work removing gravel washed into the canal channel near Gamboa by the Chagres River. It was transferred to the dry dock at Mount Hope for overhauling early in June, and on June 14, was returned to Balboa, where it was engaged alongside the steel pier and in the entrance channel until the time of its retirement. The "Culebra's" output up to July 1, 1914, amounted to very nearly 19,000,000 cu.yd. The yearly output varied from 1,785,166 cu.yd. in 1912-'13, when it was out of commission 70 days, to 3,960,153 cu.yd. in 1908-'09, with 21 days out of commission. —"Canal Record," Sept. 2, 1914.

The Calaveras Dam, California, the Highest Earth Dam

By A. J. Cleary*

SYNOPSIS—The highest earth dam now on record is the Necaxa No. 2, at Necaxa, Mexico, which has a finished height of 192 ft. The Calaveras Dam, now under construction, is to be 240 ft. high. It is to retain the water of a new reservoir for the Spring Valley Water Co. of San Francisco.

San Francisco's rapid growth has created a demand for a more adequate water-supply. The construction of the Hetch Hetchy System, recently begun by the municipality, will require some eight years to complete. Meanwhile, the Spring Valley Water Co., which now supplies practically the entire city, is increasing its resources by the erection of the largest earth dam ever built. The completion of this structure will add to the company's system a reservoir with a storage capacity of 53,000 million gallons. This reservoir site is located in the wide, level valley of Calaveras Creek, Alameda County, 36 miles southeast of San Francisco.

The watershed tributary to the reservoir extends southerly from the dam site for a distance of 25 miles, and has an area of 98.3 sq.mi. By the construction of a diverting dam on Upper Alameda Creek and a short tunnel through an intervening ridge, 35.3 sq.mi. additional may be included in the catchment area. The mountains that form the boundary of the drainage basin are precipitous, yielding a large percentage of the rainfall as available runoff. The elevation of the highest peak is 4200 and the lowest ground elevation in the reservoir is 560 ft. above sea level. The slopes of the entire watershed are fairly thickly wooded, the ground compact and, except in the valley proper, fit only for grazing. There are few properties in the drainage area not owned or controlled by the Spring Valley Water Co., and the water is thus insured from contamination.

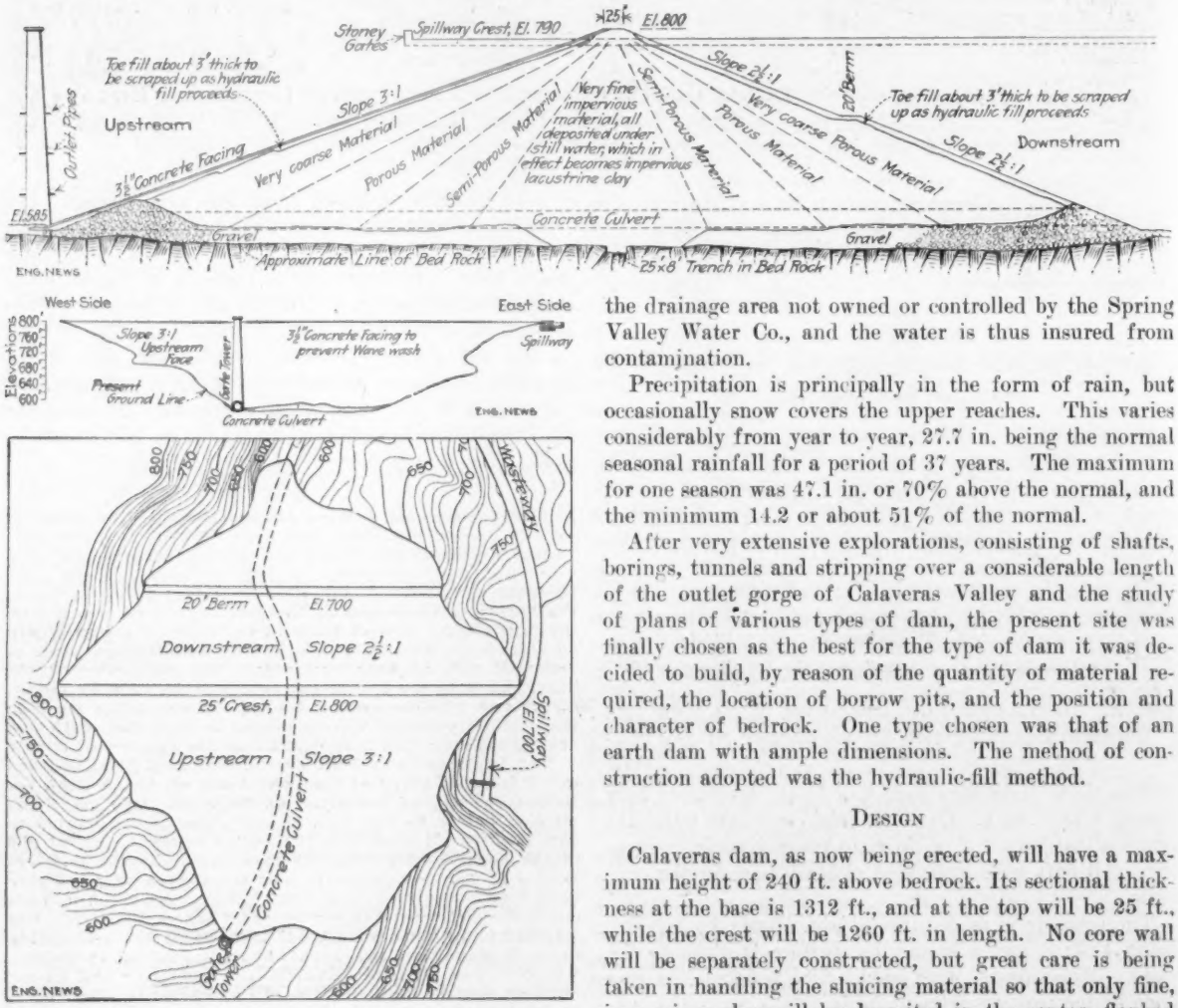


Fig. 1. Details of Calaveras Earth Dam, near San Francisco, Calif.

Precipitation is principally in the form of rain, but occasionally snow covers the upper reaches. This varies considerably from year to year, 27.7 in. being the normal seasonal rainfall for a period of 37 years. The maximum for one season was 47.1 in. or 70% above the normal, and the minimum 14.2 or about 51% of the normal.

After very extensive explorations, consisting of shafts, borings, tunnels and stripping over a considerable length of the outlet gorge of Calaveras Valley and the study of plans of various types of dam, the present site was finally chosen as the best for the type of dam it was decided to build, by reason of the quantity of material required, the location of borrow pits, and the position and character of bedrock. One type chosen was that of an earth dam with ample dimensions. The method of construction adopted was the hydraulic-fill method.

Design

Calaveras dam, as now being erected, will have a maximum height of 240 ft. above bedrock. Its sectional thickness at the base is 1312 ft., and at the top will be 25 ft., while the crest will be 1260 ft. in length. No core wall will be separately constructed, but great care is being taken in handling the sluicing material so that only fine, impervious clay will be deposited in the center, flanked on either side with porous material grading from sandy material next to the clay to heavy coarse gravel near the faces. On the upstream side the 3 to 1 slope will be

*Assistant City Engineer, San Francisco, Calif.

FIG. 2. UPSTREAM VIEW OF CALAVERAS DAM SITE, SHOWING CULVERT TO BE AFTERWARD COVERED

faced with concrete as a protection from scouring wave action. The downstream face will have a slope of 2½ to 1, with a 20-ft. berm 100 ft. vertically below the crest.

A trapezoidal spillway of ample capacity will be constructed 10 ft. below the crest of the dam. Additional drainage is provided by means of a concrete culvert which rests on bedrock for its entire length beneath the dam. This has a 15-ft. drop between the toe and heel of the dam, and a net sectional area equivalent to a 20-ft. diameter circle.

Connected to the outlet culvert by a circular concrete tunnel is a reinforced-concrete gate tower of interesting design. It is founded on bedrock adjacent to the upstream end of the culvert, and will be 229 ft. in height above the rock foundation. The shell is 4 ft. thick at the base and 1 ft. at the top, with an inside diameter decreasing from 20 ft. to 10 ft. The concrete foundation is octagonal in shape, 50 ft. in diameter, 9 ft. thick and heavily reinforced. It is of the "open" type, with outlet pipe, gate valves and stairway on the interior. A sluice gate on the outside admits water to the valves. Being located in a district generally subject to seismic disturbances, the tower has been designed especially to withstand severe earthquake shock, and the assumptions and stress analysis are of much interest.

Fig. 3. Laying culvert.

Fig. 4. Turning Arch.

FIGS. 3-4. CULVERT UNDER CONSTRUCTION

Construction

Like most Western streams, the Calaveras is of a torrential nature, varying from a few second-feet in summer to a raging torrent in winter and to provide for handling the waters of any floods that might occur while the dam was being erected, the 20-ft. culvert which will later contain the outlet pipes, was first constructed on the underlying bedrock. For this, a suitable foundation was excavated, with a 1¼-yd. steam shovel and hand work. Gravel for the concrete was conveyed by Fresno scrapers and a drag-line scraper from the gravel deposits in the creek channel 5000 ft. below the dam to an elevated platform. Thence it was washed down an inclined chute into hoppers, all silt and soluble material thus being removed. After the washing process, the aggregate in the bins below the hoppers was a clean mixture of graded sand and gravel, in which the voids averaged from 15 to 17%. From the bins, gravel was conveyed to three concrete mixers in 1-yd. cars. A 1 to 6 mixture was used throughout the structure, all joints being reinforced. A portable mixer with elevator skip and hopper shown in Fig. 4, was used to place the concrete in part of the sides and arch of the culvert. In the central portion of the dam, five large concrete collars extending into the dam and bedrock for a distance of about 10 ft. were built in as part of the culvert. These are shown in Fig. 8. The purpose of these collars is to interrupt any tendency to seepage along the surface of the culvert.

Material to be incorporated into the dam is sluiced from borrow pits down an open channel having grades varying from 5% to 7%, to an 8x8-ft. concrete-lined sump. Two monitors similar to those used in placer mining, each having a discharge that can be fitted with nozzles varying in diameter from 4 to 5 in. loosen and wash the material from the borrow pits. These are operated at a discharge rate of 7 sec.-ft. with a nozzle pressure of from 80 lb. to 120 lb. per sq.in. (For very soft material a series of 2½-in. hose jets are used instead of monitors.) The clay content of the aggregate at the borrow pit varies from 20% to 50%, with the remainder gravel and sand. In the open channel near the sump is a screen by which all boulders larger than 5 in. in diameter are removed. Water is supplied to the monitors by two 2-stage 10-in. pumps, operated at a speed of 580 r.p.m., by 300-hp. electric motors. The consistency of the mixture arriving at the sump is usually about 20% solids and 80% water. At the sump this is automatically diluted when necessary, an average of about 15% material in suspension being carried to the dam.

From the sump the solution is raised to the dam by two 12-in. mud pumps, which are driven by 300-hp. motors at such a speed that the velocity of the mixture in the

Fig. 5. Giant Monitor Sluicing Material from Borrow Pit, Calaveras Dam

discharge pipes will be from 10 to 12 sec.-ft., according to the character of the sluiced material. It is essential to secure at least this velocity in order that no heavy gravel will deposit in the pipes. To insure a steady flow at this speed a booster pump is necessary when the material is being deposited at portions of the dam most remote from the sump. As the distance to borrow pits and porous material gradually changes from large rocks and boulders at the face of the dam to fine sand at the edge of the central pool. By regulating the elevation of the water in the pool the limits of the clay core are readily regulated. No water is wasted during the process, as the drainage from the center is conveyed through a 22-in. pipe back to the sump and thus used repeatedly.

FIG. 6. DEPOSITING HYDRAULIC FILL

FIG. 7. THE SLUICED MATERIAL IN PLACE

the height of the dam increases, other booster pumps will be added. Slip-joint riveted-steel pipe, 14 in. in diameter, No. 16 gage, is used for the discharge line. To distribute the material properly and to raise the pipe line as the height of the dam increases, it is necessary frequently to disconnect and rejoin the pipe lengths. That the pipe may stand up under the ramming necessary with each change, a tip of No. 12 gage pipe 18 in. long was riveted to each end of each joint of pipe. This simple expedient has proved very satisfactory.

FIG. 8. COLLARS ON THE CULVERT UNDER THE CALAVERAS DAM

The sluiced material is discharged at the upper and lower faces of the dam and allowed to run on natural grades toward the center of the dam, where a pool of still water is constantly kept at the desired elevation. All porous material is deposited on the slopes approaching the pool, but only clay enters that portion of the dam covered by the central pool. By natural selection the

Current for construction operations is supplied by the Pacific Gas & Electric Co. at 60,000 volts. This is transformed on the work to 2200 volts.

For the hydraulicking process fifteen men are required in each shift—one on each of the two monitors and one helper for both of these; three to operate the pumps; two to keep the 5-in. screens free from boulders; two to move the discharge pipes; one blacksmith; one electrician and three general helpers. Scraper teams are employed in smoothing the slopes of the dam and carrying up small levees along each face to divert the sluiced material toward the center of the dam. A steam shovel was used to excavate a central area 150 ft. wide to bedrock along the longitudinal center line of the dam. Directly under the crest line and through this central area, a cutoff trench has been excavated in bedrock. Over 3,000,000 cu. yd. of fill will be placed by the hydraulic process.

The concrete culvert to pass flood waters was taxed to its capacity on Jan. 1, 1914, 40 days after its completion. At this time Calaveras Creek changed from a small stream to a raging torrent, following a downpour of about 4 in. in 24 hr. over most of the tributary catchment area. Water rose in the pond above the dam to a height of 9 ft. above the roof of the entrance to the culvert, making it necessary to remove a short stretch of the culvert roof during the flood. It is estimated that 6000 sec.-ft. of water passed through the culvert for a period of 10 hr. By rapid work at the levee no damage was done by this flood. Subsequently several similar floods were passed through the culvert all without mishap.

All the construction is being done by day's work. The only contracts on the job are those for hauling material, supplies and equipment, and for boarding the men.

Design and construction of the dam are under the direction of F. C. Herrmann, Chief Engineer of the Spring Valley Water Co., and Wm. Mulholland, consulting engineer. T. W. Espy is Construction Engineer in direct charge of the work.

CONTRACT DREDGING BY HYDRAULIC DREDGES, ENGINEER DEPARTMENT, U.S. ARMY, YEAR ENDING JUNE 30, 1913

Location of dredging	Depth of water, ft.	Name of contractor	Date of contract	Cu.yd. of material	Price per cu.yd., cents	Amount of contract	Character of material	Pumped per month cu.yd.	Pipe line Length, Ft.	Pipe line Dia., in.	Brief description of dredge and attending plant
Inland Waterways, S. C.	4.5	Simons-Mayrant Co.	Nov. 13, 1911	200,000	17.7	35,400	Mud, shell, marl.	20,000	300	12	12-in. hydraulic dredge, Morris pump and pumping engine.
Sabine-Neches Canal, Tex.	25	Bowers Southern D. Co.	Jan. 30, 1912	8,776,000	7.29	639,770	Clay	350,000	500	20-22	Dredge, "No. 7," 150 hp., 18-in. suction; "Gen. Mackenzie," 750 hp., 22-in. suction.
Sabine-Neches Canal, Tex.	25	W. D. Haden	Aug. 15, 1912	3,355,000	6.99	231,695	Sand, clay	125,000	600	15	Dredge, 250 hp., 15-in. suction, crew of 30 men.
Sabine Pass-Port Arthur, Tex.	26	Bowers Southern D. Co.	Nov. 7, 1912	3,397,000	8.81	275,000	Clay	125,000	450	20	Dredge, 250 hp., 20-in. suction, crew of 35 men.
Saginaw River, Mich.	10.5	Breymann Bros.	May 9, 1911	4,052,462	17.0	641,580	Clay, sand	124,300	900	20	Dredge "Enterprise," hull, 120x40 ft., 750 hp.; "Niagara," hull, 135x43 ft., 1000 hp.
Galveston Channel, Tex.	10	L. T. Gaylord	Apr. 18, 1913	4,200,000	6.7	283,005	Sand, mud, clay	269,482	400	20	
Texas City Channel	21	Bowers Southern D. Co.	Feb. 14, 1913	488,900	13.5	66,001	Mud, sand, clay	60,252	500	20	Dredge, hull, 122x36-ft.
Houston Ship Canal	13	L. T. Gaylord	June 19, 1912	20,663,000		2,365,791	Sand, clay, mud-silt	425,000	800	22	*6.95, 14.9 and 18 cents; 5 dredges.
Aransas Pass, Corpus Christi.	12	Bowers Southern D. Co.	Oct. 20, 1910	1,000,000	13.74	137,400	Shell, sand, clay	40,000	1000	20	Dredges Nos. "4" and "10."
Aransas Pass, Tex.	20	Bowers Southern D. Co.	Aug. 15, 1911	1,284,932	11.0	141,343	Sand, shell, clay	85,000	1200	20	Dredges Nos. "4" and "10."
Brazos River	5	John Jacobson	Apr. 1, 1911	2,166,800			Shell, sand, clay	100,000	800	16	*8.74 and 10.2 cents; 2 dredges.
Tampa, Hillsboro Bay, Fla.	24	J. C. Titzell	Aug. 14, 1911	4,400,000		327,800	Sand, clay, loose rock	138,000	2000	22	*7.45 and 3.725 cents; dredge, hull, 145x35x12 ft., steel
St. Johns River, Fla.	3	Bowers Southern D. Co.	June 8, 1911	3,800,000		360,000	Sand, clay	75,000	1200	18	*10.4 and 5.2 cents; dredges, "Square Deal" and "No. 9."
								185,000	1300	20	
Los Angeles	20	Tacoma Dredging Co.	Nov. 15, 1910	2,050,710	8.9725	184,000	Fine sand, shell, clay	108,387	4200	20	2 dredges, 750 and 450 hp.
Mobile Harbor, Ala.	28	Home Dredging Co.	July 17, 1911	610,290	11.99	72,750	Sand	39,229	1100	12	
Mobile Harbor, Ala.	28	Coastwise Dredging Co.	Oct. 18, 1912	1,543,791	7.3	112,178	Mud and sand	192,974	None	22	Nonpropelling hopper dredge, 6 bins, capacity, 1613 cu.yd.
Mobile Harbor, Ala.	28	Coastwise Dredging Co.	Aug. 2, 1911	3,283,339	5.38	175,273	Mud	273,612	None	22	Nonpropelling hopper dredge, 6 bins, capacity, 1613 cu.yd.
Westchester Creek, N. Y.	5	Timothy J. Dady	June 3, 1912	155,570	27.0	42,000	Mud, sand, clay, shells.	14,500	1200	15	Dredge, "Irving T.," hull, 90.5x27x11 ft., draft, 6 ft.
Hempstead Harbor, N. Y.	1	Coastwise Dredging Co.	Jan. 17, 1912	85,491	18.75	15,986	Sand, mud, gravel	14,500	350	15	Hull, 90.6x27x7 ft., 400 hp.
South River, N. J.	3	Standard Eng. Co.	Mar. 1, 1913	208,000	14.33	29,806	Sand, clay, gravel	12,339	500	15	Hull, 84x25x8 ft.; 175 hp., 15 pontoons, engine, 18x20 in. x 18 in.
Thimble Shoals, Va.	34	Maryland D. & Con. Co.	May 23, 1913	460,000	17.3	77,850	Sand			20	Not begun; seagoing dredge, capacity of bins, 700 cu.yd.
Elizabeth River, Va.	12	Atlantic, Gulf & Pacific Co.	Aug. 28, 1911	669,318	11.3	76,712	Mud, sand	133,900	1000	20	Dredge, 125x35 ft.
Thimble Shoals, Va.	31	Maryland D. & Con. Co.	Sept. 29, 1910	1,665,659	13.3	221,533	Sand	69,400		20	Seagoing dredge, capacity of bins, 700 cu.yd.
James River, Va.	18	Maryland D. & Con. Co.	Oct. 10, 1911	774,949	6.0	46,497	Sand, gravel, mud	30,634	1875	15	Dredge "Potomac," hull, 92.5x32 ft., engine, 15x32x18 in., 250 hp.
Columbia River	2	The Port of Portland	Dec. 30, 1912	1,032,000	4.59	47,000	Sand	206,476	1500	30	Dredge, "Columbia."
Oakland, Calif.	30	N. R. Harris	Nov. 9, 1911	964,285	14.0	964,000	Sediment, mud, hardpan	47,033	3000	20	
Oakland Harbor, Calif.	30	San Francisco Bridge Co.	Nov. 15, 1910	2,101,482	11.4	239,569	Sediment, mud, hardpan	51,450	3000	20	Hull, 115x40x10 ft.
San Pablo Bay, Calif.	32	San Francisco Bridge Co.	Aug. 15, 1911	2,506,000	18.88	473,008	Sandy clay, sediment	117,400	10,560	22	Hull, 138x38x12 ft., dredge, "James McMullen."
Oakland Harbor, Calif.	25	San Francisco Bridge Co.	May 15, 1913	937,500	12.8	120,000	Sediment, mud, hardpan	80,000	3000	20	Hull, 115x40x10 ft.
Savannah, Ga.	18	P. Sanford Ross	Nov. 22, 1912	850,000	10.45	88,825	Sand, clay	50,000	1000	20	600 hp.
Savannah, Ga.	22	Home Dredging Co.	July 5, 1911	1,461,902	11.6	206,395	Sand, clay, mud, snags	100,000	1000	20	Remodeled steamship hull, 700 hp.
Savannah, Ga.	22	P. Sanford Ross	Oct. 27, 1910	2,285,700	10.33	198,716	Sand, clay, mud	100,000	1000	20	600 hp.
Savannah, Ga.	12	Home Dredging Co.	Dec. 5, 1912	722,000	14.8	106,856	Sand, stiff clay	100,000	1200	20	Remodeled steamship hull, 700 hp.
Olympia, Wash.	6	Puget Sound B. & D. Co.	Apr. 1, 1912	156,264	14.0	20,505	Mud, sand	78,130	1200	20	
Willipa River	12	Puget Sound B. & D. Co.	Aug. 28, 1911	1,279,184	12.4	145,511	Silt, sand, clay	106,600	1500	20	
Bellingham, Wash.	15	Puget Sound B. & D. Co.	Jan. 24, 1912	807,273	14.4	111,595	Sand, mud, hard clay	115,325	1600	20	
Snohomish River, Wash.	6	Tacoma Dredging Co.	Oct. 23, 1911	520,700	11.2	58,318	Silt, sand	47,225	800	12	
Mattaponi-Pamunkey R., Va.	6	W. H. French	Dec. 12, 1911	121,568		23,256	Sand	5,600	1200	12	*Mattaponir., 19½; Pamunkey R., 18½ cents. Dredge, "Mary," 67x23.5x6 ft.
Rappahannock River, Va.	12	Miner Engineering Co.	May 9, 1912	36,000	23.0	8,280	Mud, sand	10,500	1200	12	Dredge, "Grey Eagle."
Anacostia River	16	Sanford & Brooks Co.	Jan. 23, 1912	1,076,175	5.49	59,082	Mud	129,575	4000	20	Dredge, "Dewey," hull, 97x34x9.5 ft.
Aquia Creek, Va.	7	W. H. French	Nov. 25, 1912	154,000	10.7	16,478	Mud	9,292	920	12	Dredge, "Mary," hull, 67x23.5x5 ft.
Maurice River, N. J.	3	The Rickards Ddg. Co.	Feb. 26, 1913	90,000	15.5	13,950	Sand, gravel	25,813	250	15	Dredge, "No. 5," 90x32x9 ft.; engine, 15x18x18 in.
Absecon Creek, N. J.	6	Hill Dredging Co.	Feb. 27, 1913	90,000	10.5	39,450	Mud, sand, oyster shells	35,000	300	12	Dredge, "Black Diamond," hull, 76x22x6 ft.
Cold Spring Inlet, N. J.	8	American Dredging Co.	Mar. 18, 1912	841,996	6.8	57,800	Mud, sand	67,400	1000	20	Dredge, "New Jersey."
Wilmington Harbor, Del.	16	American Dredging Co.	May 2, 1912	1,460,000	8.3	120,000	Sand, mud, gravel, clay	120,687	7920	15	Dredge, "Maryland," hull, 110 ft. long, engine, 450 hp.
Beaufort Harbor, N. C.	10	D. Clinton Mackey	Dec. 18, 1912	221,408	10.5	16,427	Sand, mud	78,200	500	20	
Morehead City, N. C.	10	D. Clinton Mackey	Dec. 18, 1912	152,000	10.5	15,960	Sand, mud	99,300	500	20	
Smiths Creek, N. C.	10	D. Clinton Mackey	Dec. 18, 1912	130,000	10.5	13,650	Sand, mud	72,600	500	20	
Cape Fear River, N. C.	26	Bowers Southern D. Co.	Dec. 23, 1912	1,369,863	10.95	150,000	Sand, mud, roots, stumps	105,045	1400	*	

*One 20-in. and one 15-in. dredge.

Contract Hydraulic Dredging for United States Government

In addition to the extensive dredging plant operated under the direction of the Engineer Dept., U. S. Army, a great amount of dredging is done by contract. The contract dredging for 1913 is shown in the accompanying tabulation compiled from the official report of the Chief of Engineers. As a rule, the major portion of this class of dredging is done in coast harbors along the Atlantic and Pacific Oceans and the Gulf of Mexico; an exception is the hydraulic dredging in the Saginaw River, Mich. The table is arranged by districts, alphabetically.

Dust Used Instead of Cement; Packed In Cement Bags

Dust Used Instead of Cement; Packed In Cement Bags—Defective concrete said to exist in a piece of public work in Los Angeles, Calif., is explained in a novel and ingenious manner. What was thought to be cement was only dust! And this dust was packed in cement bags, came from a cement mill, and had been used accidentally, in good faith, by the contractors. A local newspaper gives the facts as follows:

> Early yesterday the board of public works learned of the fault with the concrete was caused by the accidental use of dust instead of cement in mixing the concrete. The contractors explained that in some unaccountable manner evidently the manufacturers of the cement had shipped the dust in cement sacks, and it had got mixed with good cement. This dust is used by paving companies to dust off new asphalt. The board of public works accordingly issued an order that in future on all street contracts the dust used for this purpose must be packed in sacks of a different appearance from the regular cement sacks.
>
> Further news is to the effect that the board has ordered all cement and sand to be tested before use instead of afterward.

Editorials

Clams and Hope on the New Haven

In these times of business storm and stress, it is well worthy of record when one finds in a railway financial report a note of hope and optimism. Still more remarkable is it when such a thing is found in a report issued by the New Haven Co. It is surely of interest to repeat, therefore, from the report of the net corporate income of the New York, New Haven & Hartford R.R. for the month of July, just made public, the following twang of a cheerful lyre:

> An interesting incident in New England commerce is the discovery of a very large deposit of clams between Martha's Vineyard and Nantucket. These are being moved in large quantities, principally to the New York markets, and the deposit appears to be large enough to insure a business for several years at least.

If the Stock Exchange were only open, this news ought to be worth a two-point rise in New Haven stock. If the retiring clam can aid in hoisting the New Haven out of the financial mire, and at the same time reduce the high cost of living in the metropolis by adding a durable article of diet to its food supply, the tale of its achievements may well be spread abroad. Perhaps some member of the talented literary staff who served under the former New Haven regime, writing "Prayers from the Hills" and other masterpieces, might celebrate the achievements of this gentle shellfish in lyric song.

The one disquieting note in the above quotation is the suggestion that this colony of clams is being treated like a mineral vein, and that in a few years is likely to be worked out. It is to be hoped that the compiler of this financial report has made some mistake and merely used the language to which he was accustomed in connection with copper, or iron, or coal mines in some previous railroad service. To exhaust a deposit of clams on the Rhode Island coast would be a calamity not lightly to be borne. Not even the financial exigencies of the New Haven Co. could justify such extremes of exploitation. The public will earnestly hope that so long as the New Haven Railroad continues to run, the deposits of Rhode Island clams will not be exhausted.

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Injuries from Nails

To step on the point of a nail causes a direct loss of money. Somebody has to pay for the resulting injury, which is often a serious one. Unfortunately, the man who leaves the nail sticking up is seldom the one to step on it. But in the long run, if A steps on the nail that B left, and B steps on C's nail, C on A's, or otherwise around the circle of events, the situation is much the same as if every man that left a projecting nail point where somebody could step on it or catch on it was likely to suffer the injury himself. This is a clear argument for more care in dealing with projecting nails.

Two concerns state that injuries from nails form 3 to 6% of their total casualties, according to George Gilmore, Chief Engineer of the Travelers Insurance Co. "The Travelers' Standard" in an article on the nail hazard points out further that clinching a nail may make it more dangerous than the straight projecting point, if the clinching is not thorough. A nail point bent over so that it is nearly flat on the face of the board but yet clear of it a few sixteenths of an inch may catch the foot or hand to worse effect than an unclinched point, while at the same time it seems safe and thus invites the accident. The safe clinch shows the point is buried in the wood.

Under the workmen's compensation law now in force in many states, injuries to workmen from projecting nails may easily transform the profit on a contract into loss.

⁂

A Series of Papers on the New York Rapid Transit Railway Construction

We begin the publication in this issue of one of the most important and valuable contributions to engineering literature that ENGINEERING NEWS has ever had the pleasure of laying before its readers. We refer to the articles on the New York Rapid Transit Ry. extensions by Fred Lavis. Mr. Lavis' high reputation as an expert in connection with railway and tunnel construction is well known to many of our readers. He has made a special study of the New York subway construction in all its phases, and is to present the results of this study to the profession through our columns in a series of articles. Each of these will take up some special part of the work, so that each article will be complete in itself, and the entire series will make a complete technical account of the greatest piece of engineering work, figured by total expenditure, that has been undertaken in the world, almost without exception.

This series of papers will be of value not merely to engineers engaged in city rapid-transit subway construction in the future, for there is no doubt that other large cities will adopt this system of rapid transit to a great extent during the next quarter century. They will be of value also to engineers and contractors engaged in a great variety of construction work.

Take, for example, the underpinning of buildings affected by deep excavations, a class of work that has to be done at times in almost every city of the country. It is safe to say that nowhere in the world has building underpinning been carried out on such an enormous scale and under such difficult conditions as has been the case on the subway construction. The same thing may be said of deep tunneling under navigable rivers, of deep trenching through city streets, of provision for gas pipes and water mains, electric wires, and other underground street furniture in connection with large street excavations, of the transport of excavated material in crowded city streets, and of a number of other important primary operations in connection with the New York subway construction.

It must be remembered, moreover, that the engineering problems in connection with the New York Rapid Transit Ry. system, including the design of the completed

structure and the methods of construction, have been thoroughly studied by the largest staff of engineers, probably, that has ever been brought together in connection with any great public work. Speaking broadly, therefore, it may be fairly presumed that the New York rapid transit railway construction represents as good work as the engineering profession of the present day is capable of producing, while the methods adopted by the contractors on the various sections can safely be assumed to typify the best construction practice at the present day.

It may readily be understood that the difficult task of the author of these articles was to judge what to omit as well as what to include. The rigid limitations as to the space which could be spared in the crowded columns of ENGINEERING NEWS for the description of even so noted a work made it necessary to select only the features of greatest technical importance.

In describing a work of such magnitude, spread over such a wide area and involving so many features of difficulty and unusual practice at various points, it would have been easier to have made a description four times as voluminous as the present series of articles. The critical reader who follows these articles in detail will perceive that what has been presented in them are the technical facts of greatest interest and usefulness to the working engineer, while preserving enough of the general features to be interesting to the general reader.

A word of appreciation and acknowledgment is also proper here to the numerous members of the engineering staff of the Public Service Commission who have courteously aided Mr. Lavis in his work of collecting this information, as well as to the contractors and their engineers on the various sections, who have likewise extended to him much valuable aid.

Broken Rails and Derailment Accidents

In commenting on the causes of railway derailments in our issue of Aug. 13, we reviewed the statistics given in the accident bulletin of the Interstate Commerce Commission for the last quarter of 1913. It showed that only 128 derailments occurred in the three months on railways in the United States which were traced to broken rails At this rate, the total in a year would be 512.

A well known railway engineer, writing us to comment on these statistics, states that on his own road alone with about 1350 miles of track, about 500 broken rails occur per annum. There are, he estimates, judging from his own experience, at least 500 cases of broken rails to one derailment caused thereby. At this rate the actual number of rail breakages in a year on the railways of the United States would be in the neighborhood of 25,000. Actually the number is likely three times as great.

The explanation of the seeming discrepancy is that the Interstate Commerce Commission's statistics of accidents includes only those accidents which are reported to it; and its rules require the reporting only of accidents which either cause loss of life or serious injury, or which do damage to property exceeding a certain minimum amount. There are probably somewhere from three to four to a dozen derailments which cause no damage of consequence to every derailment which is serious.

Our correspondent makes the further point, however, that the deduction in the latter part of our editorial as to the general character of the rails now in service were not warranted. As to that, there may be two opinions. The statistics which we quoted certainly indicated that the danger from broken rails is not the appalling menace to the safety of railroad travel that might be supposed from some of the published matter on the subject of rail breakage. It is entirely true, on the other hand, that the great number of rail breakages in comparison with the derailments due to broken rails make statistics of the latter an unsafe basis for forming conclusions as to the character of the rails in service.

Inspecting Injured Bridges After Train Wrecks

An unusual bridge wreck on the Wabaash R.R., at Attica, Ind., on Apr. 5 last, has just been reported upon by the Interstate Commerce Commission. As our readers will recall, this accident was described by Prof. Albert Smith of Purdue University, in our issue of Apr. 16. A derailed freight car struck the end post of a Pratt truss bridge, partially shattering it and bending it 6 in. out of line. It still had strength enough, however, so that the bridge stood up without collapsing. The engineer of the freight train pulled the front portion of the train to a siding and then came back, ran his locomotive onto the bridge, pushed the derailed car across it, and the car was then thrown down the bank to clear the tracks for a fast passenger train which had been held up. That train was then allowed to come over the bridge at a speed of not more than 3 or 4 miles an hour, and under its weight the bridge collapsed.

The technical features in connection with the stresses in the injured end post were reviewed in our issues of Apr. 16 and 23. The feature of chief interest in the Interstate Commerce Commission Inspector's report is the attempt to fix the responsibility for permitting trains to pass onto the bridge span in its dangerous condition.

It is clearly evident that none of the trainmen or trackmen at the site of the wreck had any idea that the injury to the bridge's end post, which was, of course, in plain sight to everyone, was a matter involving any serious danger. In fact, the whole matter of clearing up the freight wreck and moving cars and locomotives over the bridge, was handled by the ordinary train crew with the aid of a wrecking crew from Lafayette. The only man representing the Maintenance-of-Way Department, higher than a section foreman, was a track supervisor, who said frankly in his examination by the Inspector that he did not know much about such bridges, and that he did not talk over the condition of the bridge with anyone except the section foreman. He said the bridge looked all right to him.

The only man who seemed to have any idea that the bridge had received serious injury and should have expert examination before trains were allowed to go upon it, was the telegraph operator at the station nearest the bridge. He was, in fact, directed by the train dispatcher after the wreck occurred, to go to the bridge and see what damage had been done; and after inspection he wired the dispatcher that the end-post had been knocked out of line and that a bridge man should be summoned. The dispatcher consulted with the chief dispatcher, and they decided to have a bridge man go to the site of the wreck, but the only one they could secure was the track supervisor above referred to. The fatal mistake of relying

on the judgment of a track supervisor as to the safety of an important bridge structure under such conditions was very shortly demonstrated.

It is not to be expected, of course, that the ordinary train crew, or track foremen or supervisors would be competent to pass expert judgment upon the strength of an injured bridge. The important thing is that these men should not rely on their own judgment in cases of doubt.

The possibility of just such an accident as this on the Wabash exists on many another railway. It would seem well to add to the rules for trainmen and foremen of wrecking crews some rule reading somewhat as follows:

> If any car or locomotive is derailed on a bridge or runs onto a bridge after derailment, examine the structure carefully, and if any parts of it other than the rails, ties, and guard timbers, have been struck and injured, report conditions fully to train dispatcher, who will notify Bridge Department and secure authorization therefrom before permitting any locomotive or car to cross the bridge.

The Responsibility for River and Harbor Appropriations

As briefly reported in our last week's issue, the U. S. Senate, on Sept. 22, passed the shortest river and harbor appropriation bill on record, and in doing so established a precedent which may possibly bring about a sweeping reform in the method of conducting our public works.

The bill simply provides a lump sum of $20,000,000 to be expended on the preservation and maintenance of river and harbor works already completed, and the prosecution of other river and harbor works already authorized by Congress. The entire responsibility for the expenditure of this appropriation and its distribution among the different works is placed upon the Corps of Engineers and their official head, the Secretary of War. In the apportionment of the money to various projects, the engineers are merely directed to favor those which are most desirable in the interest of commerce and navigation and which can be most economically and advantageously carried on.

It is seldom indeed that such sound common sense and businesslike procedure characterizes a piece of Congressional legislation. It is fair to say that the Senate passed this model river and harbor bill not by any means because of statesmanlike ambition to effect a reform in legislative procedure, but because the bill appeared to be a last resort if any appropriation for rivers and harbors was to be made at this session.

As already recorded in these columns, the bill as it was originally reported to the Senate from the Committee on Commerce carried appropriations of over $57,000,000 and was substantially the House Bill, with numerous changes and additions to suit the ideas of various Senators as to what should be provided for expenditure in the different States and districts.

The unanswerable criticism of this bill made by Senator Burton of Ohio, ably assisted by a number of other Senators, showed so fully the criminal wastefulness of the measure that the Senate eventually awoke to the fact that the enactment of the bill as originally reported would be political suicide. To revise the law, however, and include only meritorious appropriations meant that the amended measure would incur the hostility of every Senator whose pet appropriation was eliminated. The only way out of the difficulty, therefore, appeared to be for the Senate to abandon all responsibility for the apportionment of the money to the different localities and place that responsibility where in our opinion it properly belongs—with the engineer officers in charge of the work.

It still remains to be determined, of course, whether the House of Representatives will consent, like the Senate, to abrogate its powers heretofore exercised. That there will be violent protest against this is not to be doubted; but those who protest are likely to consider also that if they do not accept the Senate bill, there is little chance that any river and harbor appropriation bill of any sort can be passed at this session. There seems good ground for hoping, therefore, that the House will finally determine to accept the Senate bill with such grace as it may; and that the country may witness the remarkable spectacle of Congress providing a lump sum appropriation to be spent on public works, not for the purpose of enabling the Congressman from this or that or the other district to retain his seat in the House, but purely for the benefit of commerce and navigation.

It is understood, of course, that this handing over of responsibility by Congress is only temporary and also that it is not complete, since the responsibility of the engineers is confined to distributing the appropriation among the projects already authorized by Congress. Distinguished Senators and their colleagues in the House are, of course, firm in their intention to retain the say as to what new works shall be taken up; and they doubtless intend next year to resume their old plan of parcelling out the money for maintenance to each different item of work.

Notwithstanding this, a most important precedent has been established and it seems not too much to hope that in the light of this precedent public opinion may yet compel Congress to relinquish the responsibilities that do not properly belong to it at all and allow the public works of the country to be planned by experts with regard solely to their merits and usefulness.

It may be argued, of course, that the Corps of Engineers is fitted to pass on technical questions only and is incompetent to pass upon the complicated matters of commerce and economics involved in the decision as to whether or not a particular navigation improvement is worthy of being undertaken in view of its cost and its promise of commercial importance.

We may admit, for the sake of argument, that the Army Engineers are not infallible judges in these matters; but experience has demonstrated that Congress is not only still farther from the ideal in this respect but that as a matter of fact it does not attempt to judge. A large proportion of the projects to which it allots appropriations are only ostensibly for the benefit of navigation. Their real purpose is to secure the expenditure of money in a particular Congressional district. Surely the time is past when the waste of government funds in this way can be successfully defended. In fact, a large proportion of the Congressmen who take part in this annual pork-barrel distribution frankly condemn the system and accept it merely because it is a part of an established political custom which they deem themselves powerless to change.

It should not be overlooked, either, that this long established practice of distributing river and harbor appropriations among different Congressmen practically destroys the possibility of any intelligent systematic effort to improve our systems of inland navigation on a sound

and well considered engineering plan. It has been frequently pointed out to the public by the Inland Waterway Commission and other official bodies during the last few years that what is needed most of all in our river and harbor work is systematic and intelligent planning, so that the work may be concentrated where it will be of real public benefit instead of frittering away appropriations on unrelated projects and doling out the money for important works over such long periods of time that the whole scheme is obsolete before it is completed.

If Congress a dozen years ago, for example, had had the wisdom to place the entire work of navigation improvement in the hands of an able commission appointed by the President, made up largely of expert engineers of the highest standing and had provided for the use of that commission an annual sum no greater than has been expended on river and harbor works during that time, such a body would have been able to concentrate expenditures on works of real commercial value. By this time there might have been completed some of the large and important works that really promise enough benefit to navigation to be worth their cost.

And it is worth while, in connection with the above discussion, to point out that the principle involved is really far broader than the matter of river and harbor appropriations. There would be a vast improvement in legislative procedure and an immense public benefit if Congress would relinquish its long-established habit of framing appropriation bills to provide specific sums for each specific object, even going down so far as to fix the salaries of individual employees which the bill provides for. Such work does not belong at all to the legislative department of government. So far as Congress undertakes it, it does so to the neglect of other and far greater responsibilities.

Furthermore, this distribution of appropriations is actually not the voice of Congress at all, and often not even of the subcommittees of Congress, but is carried out by some clerical assistant to whose work a perfunctory approval is given. It would be vastly better to wipe out this absurdity altogether and provide in all cases lump-sum appropriations for general purposes, leaving to the executive officers in charge the apportionment and distribution of the appropriation in the manner which will be most to the public interest.

While the river and harbor bill which passed the Senate on Sept. 22 is a long step in this direction, it would be too much of an approach to millennial perfection to hope that any such principle will be carried into effect in the general conduct of our National legislation.

Letters to the Editor

Bridge Rerailing Frogs

Sir: I have noticed on p. 408 of your issue of Aug. 20, a reference to rerailing frogs, placed in the inner guard rails on the approach to a bridge, to eliminate danger by catching rerailed wheels and guiding them back on the rails. Will you kindly inform me where I can obtain a sketch and description of this device?

F. GAMBLE, Chief Engineer,
Department of Railways, B. C.

Victoria, B. C., Canada, Sept. 2, 1914.

[Inquiry of a large number of frog and switch companies shows that five make or are prepared to make rerailing frogs. Three of these refer to the Childs-Latimer frog (the patents on which expired long ago); the Weir Frog Co., Cincinnati, Ohio, the Morden Frog & Crossing Works, Chicago, and the American Frog & Switch Co., Hamilton, Ohio. The Pennsylvania Steel Co. has made rerailing frogs to the designs of the Pittsburgh & Lake Erie R.R., and the Pettibone, Mulliken Co., of Chicago, has made them to the designs of the Morgan's Louisiana & Texas R.R. The Southern Pacific Ry. also has a design of its own.—EDITOR.]

Still More about Teredo-Proof Piles of Australian Woods

Sir: The letter in your issue of May 21, entitled "More about Teredo-proof Wood Piles," states that turpentine and ironbark are identical. Actually, they are far different both in appearance and strength.

Ironbark is practically never driven with the bark on; while turpentine always is, and the bark is its protection. The latter timber is not very much used here as we have other borers which attack it. For temporary use, or in fenders, we often use swamp mahogany with bark on; but the regularly accepted pile (where not exposed to fretting) is ironbark (Eucalyptus creba by preference) sheathed with muntz metal.

Ironbark is one of the strongest and most durable timbers known. I have sample ties of it as sound as a bell after 45 years, and the average life of such a tie is at least 25 years.

W. PAGAN.
Recently Chief Engineer, Queensland Rys.
Brisbane, Australia.

On the Necessity (?) for Heavier Pavement Foundations

Sir—In ENGINEERING NEWS of July 23, 1914, p. 176, there appears an article on concrete foundations for pavements, in which the experience of the English engineers does not seem to be duplicated here.

In the operation of repaving many thousand square yards of streets in New York I have had occasion to examine carefully the old concrete foundations. In many cases these were made with Rosendale (natural) cement. I have yet to see any evidence of crushing of the concrete foundation from excessive loads.

The foundations on some streets did not exceed 4 in., and averaged 3 in., and, while being removed, came up in large cakes 3 to 4 ft. wide, requiring several blows from

sledges to break the cakes. Cracks found in the concrete plainly seemed to be due to the settlement of the earth foundation, as the distance between the cracks was considerable.

Where cave-ins occur it is often found that the concrete foundation apparently had for some time been spanning a hole 3 to 4 ft. across and finally gave way when the span became too great. A cavity as large as 30x12 ft. has been discovered by a hole about a foot square finally being broken in by a truck. The concrete here was only 6 in., the usual thickness.

Much of the area paved with asphalt blocks in New York City has a foundation of only 4½ in. thick, as the ½-in. mortar bed cannot properly be considered concrete foundation. In the Borough of Manhattan the standard thickness of concrete foundation is now 6 in., increased occasionally where required over bad material.

Unless provision is to be made for spanning such large cavities as are mentioned above, it would appear that the present thickness of 6 in. of 1:3:6 concrete of the quality now being laid is quite sufficient.

R. A. MacGregor.

2428 Lorillard Pl., New York City, Sept. 8, 1914.

Need of a Home Export Manager for South American Trade

Sir—One important point is apparently overlooked in the present movement toward developing better American business relations and trade with the countries of South America—that is, the need of an Export Manager in the home office, who has been trained in those countries and appreciates their needs.

The obstacle that presents itself is that the United States is not prepared to meet the conditions and requirements of the South American trade. In fact, American firms, except a very few, know nothing about these requirements; but doggedly insist upon the foreign trade accepting what the American firms presume in their ignorance to offer them.

The fact has been that the representative, engineer, contractor or merchant of the South cannot obtain what he wants when he places his order in the United States. Cabled orders are not given due notice, and it is not uncommon after giving an explicit order for timed delivery, followed up by cables, to find on the ship on which the goods are expected, a letter proposing to send something different than ordered, under the excuse that the purchaser was ignorant of what he wanted, whereas in fact the ignorance was on the part of the American firm.

Troubles in packing and labeling are met in ordering steel, mill work and almost every constructive material, whereas orders to Europe will bring the article just as ordered without delay or question on the set time and with the advantages of low freight rates in European bottoms. The high American shipping rates in American colonies such as Porto Rico were partly offset by the former high tariff, but even there the Europeans met the American prices C. I. F. in spite of the American customs duty. This condition must be attributed to the ignorance on part of the Americans at home and the knowledge on the part of Europeans of the requirements of the South American trade. The manufacturers of the United States are just awakening to the necessity of adjusting themselves to the requirements of this trade.

The banking system is being extended by large banking houses, and there is no doubt but what the American banker will meet the demands as he sees the value of the business. The Canadian banks are there in full strength, have studied the requirements and are pushing themselves in wherever there is an opening.

The American steamship companies now have their opportunity while the war is on to get fully into the field. By the time that European ships come again into the field, the steamship companies may win a subsidy from the government; or if not, they can at least take advantage of the situation now and foreign bottoms can be used again after the war to carry American goods.

The manufacturers and supply people in the States, however, are complaining about the man in the field. They fail to see that they need an experienced Export Manager at home to understand the orders from the representative in the field and see that the orders are properly handled. The American representative resident in the foreign country soon learns to conform to the new condition by necessity; but his hands are tied if he is not understood in the home office.

American supply houses require Export Managers who have graduated through years of experience in the field. They should be drawn from men who have been trained in South American countries and probably have been promoted to Managers in their fields. The Export Manager at home should be the next step; but the supply house has failed to see the necessity of that important position.

Frederick O. Lewis.

130 Peterboro St., Detroit, Mich.,
Aug. 31, 1914.

NOTES AND QUERIES

Notes and Queries—"Subscriber" is informed that anonymous communications cannot receive attention from the editors.

Girard Point Elevator—The following corrections are to be noted in the article by S. H. Ingberg in "Engineering News," Sept. 17, 1914. On p. 573, fifth paragraph, is the statement "Each band is made up of two lengths lapping 3½ in." etc. This should read 3½ ft. In Section AA, Fig. 4, p. 575, the lower first floor should be 7 in. instead of the 4 in. shown.

The Code of Ethics of the American Society of Civil Engineers has been adopted by a letter ballot vote of 1997 to 107. This code of ethics was printed in "Engineering News" of Apr. 30, 1914, previous to its discussion at the annual convention of the Society at Baltimore, Md. It is reprinted below, together with the result of the canvass of ballots:

It shall be considered unprofessional and inconsistent with honorable and dignified bearing for any member of the American Society of Civil Engineers:

(1) To act for his clients in professional matters otherwise than as a faithful agent or trustee, or to accept any remuneration other than his stated charges for services rendered his clients.

(2) To attempt to injure falsely or maliciously, directly or indirectly, the professional reputation, prospects or business of another engineer.

(3) To attempt to supplant another engineer after definite steps have been taken toward his employment.

(4) To compete with another engineer for employment on the basis of professional charges, by reducing his usual charges and in this manner attempting to underbid after being informed of the charges named by another.

(5) To review the work of another engineer for the same client, except with the knowledge or consent of such engineer, or unless the connection of such engineer with the work has been terminated.

(6) To advertise in self-laudatory language, or in any other manner derogatory to the dignity of the profession.

Total number of ballots received	2316
Ballots irregular	154
Ballots to be canvassed	2162

Total affirmative votes, 1997.
Negative votes, 107.

Pavement Records to Determine an Economical Policy in Repairs and Reconstruction

The Bureau of Highways of Philadelphia, Penn., of which William H. Connell is Chief, has devised and put into operation a system of pavement records which is designed to furnish not only a complete history of each city block of street pavement, but the data upon which to determine the proper policy to pursue with regard to continuing repairs to a street, repaving it, or changing the kind of pavement for one more suitable to the prevailing conditions. In other words, the information contained on these cards can be used to determine the economical life of the existing pavement and the type of pavement to be used in repaving to suit traffic conditions.

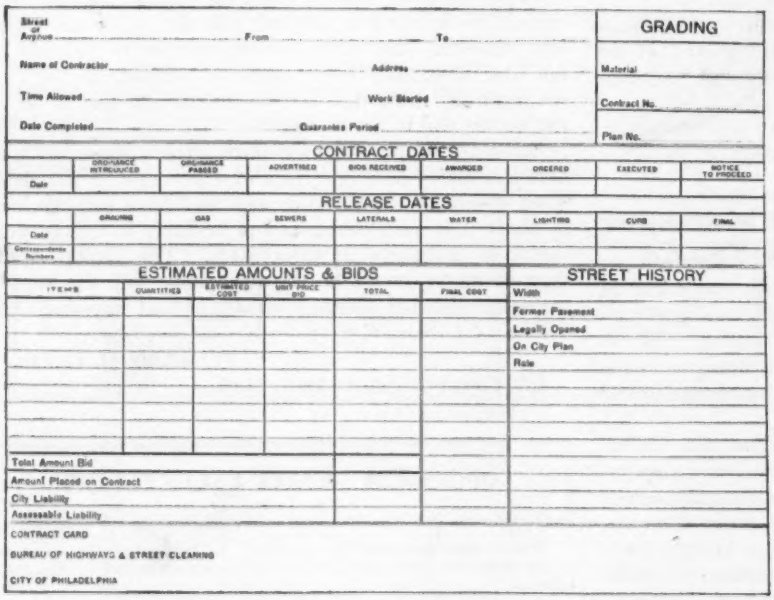

Street or Avenue ..... From ..... To .....
Name of Contractor ..... Address .....
Time Allowed ..... Work Started .....
Date Completed ..... Guarantee Period .....
GRADING
Material
Contract No.
Plan No.
CONTRACT DATES
ORDINANCE INTRODUCED | ORDINANCE PASSED | ADVERTISED | BIDS RECEIVED | AWARDED | ORDERED | EXECUTED | NOTICE TO PROCEED
Date
RELEASE DATES
GRADING | GAS | SEWERS | LATERALS | WATER | LIGHTING | CURB | FINAL
Date
Correspondence Numbers
ESTIMATED AMOUNTS & BIDS
ITEMS | QUANTITIES | ESTIMATED COST | UNIT PRICE BID | TOTAL | FINAL COST
Total Amount Bid
Amount Placed on Contract
City Liability
Assessable Liability
STREET HISTORY
Width
Former Pavement
Legally Opened
On City Plan
Rate
CONTRACT CARD
BUREAU OF HIGHWAYS & STREET CLEANING
CITY OF PHILADELPHIA

FIG. 1. RECORD CARD OF PAVEMENT CONSTRUCTION (GRADING), 11x8½ IN., PHILADELPHIA BUREAU OF HIGHWAYS

CONSTRUCTION RECORDS—Construction-record cards are of five kinds: grading, printed on a yellow card; paving, a white card; resurfacing, a brown or salmon card; repaving, a blue card, and miscellaneous, a pink card. All cards are the same size, 11x8½ in., and identically the same except in color and filing title. Fig. 1 shows the face of one of these cards, and Fig. 2 the reverse side of one.

As is readily seen by an examination of these reproductions, they furnish all the essential information in regard to construction of the pavement, for future study and reference. The reverse of the cards, Fig. 2, shows the method of cross-hatching the printed plan, so that the progress of the work may be followed in the office. The second plan and following remarks are for records of subsurface structures. Needless to say these cards also serve admirably as cost data records, and as records of the efficiency of the various contractors.

MAINTENANCE RECORDS—These cards (Fig. 3) contain the history of the original paving of each block and street intersection, together with the maintenance data of pavements laid since Jan. 1, 1912. The reverse side of each card is used for a stereotyped sketch of the block or street intersection, and, where practicable, shows the approximate location of each patch or section repaired. The cards for blocks of pavements are white, and for street intersections are green.

Many of the streets in the older portions of the city are narrow and are paved with asphalt on a broken-stone base. They are subjected to very heavy traffic which is concentrated largely on the shoulders, because of the street-railway track, and patching is done in the same places every year. Chestnut St. and Walnut St., between the Delaware and Schuylkill Rivers, are examples of this kind of street. The plotting of the patching done on these streets show that patching is in the same places each year, and brings out the high cost of maintenance required and serves as a powerful argument for replacing the old paving with a new one on a suitable base.

Another matter which these cards will control is the cost of restoration of the pavement over cuts made by plumbers and others having permission to open the streets. The data thus obtained will be used as a basis for obtaining equitable rates to be charged in cases of this kind.

The accompanying directions to engineers of the Bureau of Highways explain more fully the use of the street-maintenance record cards, which bid fair to become a most essential part of the Bureau's records.

DIRECTIONS FOR MAKING SKETCHES ON CARDS FOR HIGHWAY RECORDS

STREET—A street is a highway opened for vehicular traffic, as defined in Street Cleaning Specifications, and the names will be found in the street-cleaning reports of the highway district engineers.

BLOCK—One block will be shown on one card. One block is the distance between adjacent curb lines of the boundary streets, and generally includes the house numbers between any one hundred numbers.

ORIENTING—The top of the card is north for all east and west streets.

The left edge of the card is north for all north and south streets.

INTERSECTIONS—Intersection cards (green) will be made out for all intersections of streets which are boundaries of blocks, and for intersections of main streets which are not block boundary streets with block boundary streets and with each other. The intersections of the small streets with the main streets and of the small streets with each other will not be shown on intersection cards.

BLOCK AREA—The block area will include the area comprised within the limits shown on the card, after deducting the areas of any intersections which may be shown on any other cards, and any portion not paved. Generally the block area will be included between the curb lines of the block and the adjacent curb lines of the streets at each end of the block.

EXCEPTION—When a street is paved to the property line at the intersections of streets which are not graded or paved, the parts of such intersections outside of the curb lines shall be included in the block area.

Special care must be exercised to avoid any duplication of block areas or of the areas of the several kinds of paving making up the block areas.

Any portion of the street area shown on the card which is shown on an intersection card or which for any other reason

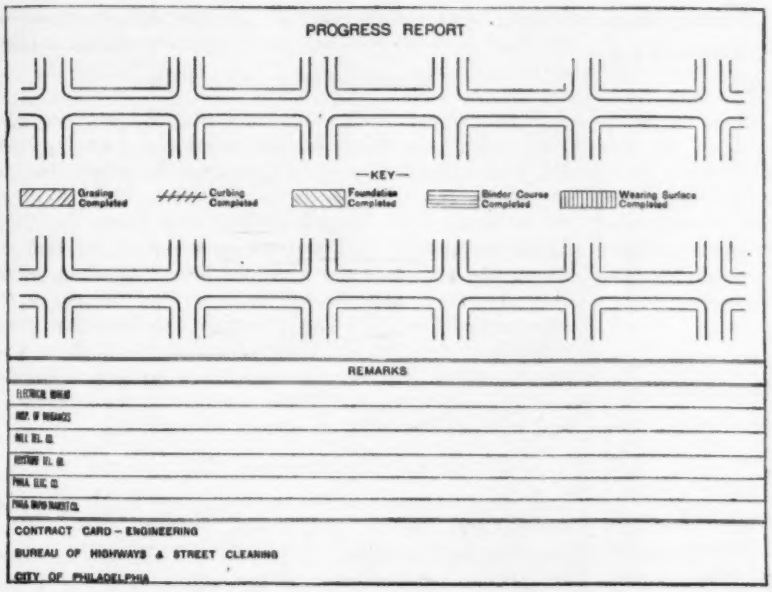


FIG. 2. RECORD CARD OF PAVEMENT CONSTRUCTION (PAVING, REVERSE SIDE), 11x8½ IN., PHILADELPHIA, BUREAU OF HIGHWAYS

is not to be included in the block area shall be plainly marked and with directions for reference if necessary.

Block areas will include areas comprised between the extensions of the curb lines and the radius corners.

LETTERING, ETC.—The name of the street and of the boundary streets shall be printed in CAPITALS. The remainder of the card above "Maintenance Data" on one side and above "Remarks" on the other shall be printed in script. As far as possible the space between the curbs shall be reserved for future entries and only street and curb widths and street grades shall be entered between curbs at this time, and such entries shall be made as small as possible. Grades shall be shown by the percentage of fall per foot, and the direction of the fall by an arrow point at the word "Grades." (Lengths of property lines between adjacent streets shall be noted on the footway opposite and in small figures.) The block length comprising the distance between the adjacent curb lines of the end streets shall be entered in its place below the lower property line.

If the block length of the upper side of the block is different from the lower block length, it shall be so entered above the upper property line. If both property lines are the same, the lower entry will be sufficient. All property lines and block lengths shall be to the nearest tenth of a foot. Street, curb and footway widths shall be entered according to the city survey plans.

INTERSECTING STREETS—All intersecting streets shall be drawn to scale, showing footways, roadways and radius of corner. The footway and roadway widths shall be entered at the right end of the card under "Remarks," one entry on each line, and shall be marked by letters, as "A," "B," etc., referring to similar code letters on the sketch

The space back of the house lines shall be kept for the future sketching of house and property lines. The space after "Square Yards" shall be kept free for the entry of the areas of the several pavements comprising the block area.

DIAGONAL STREETS—Owing to the difference of the longitudinal and transverse scales of these sketches, as printed on the cards, the direction of the diagonal streets will be shown by lines drawn through the corners of the property lines when plotted to the horizontal scale on the sketch. This applies to both intersecting streets and end streets.

ANGULAR AND CURVED STREETS—All angular, curved and other irregular streets and straight streets intersected by diagonal streets running in two or more different directions, shall be plotted on the special blank cards and to such scale as will best fill the card. The roadway and footway widths to be exaggerated as on the printed form when possible.

INTERSECTION CARDS—The highway intersection record cards (green) shall be filled out in the same manner as the highway block record cards. Special and irregular intersection cards will be used for all intersections which are not rectangular.

When plotting offset intersections where the line of one street is offset, the intersection will be located in the straight street opposite that portion of the offset street which divides the through street at the point where the numbering changes.

HOUSE AND PROPERTY LINES—House and property lines shall be plotted on the highway block cards so that the distance from the block corner to the nearest property line of the property so plotted, or the distance between the adjacent property lines of the properties so plotted shall not extend 100 ft. The frontage of the plotted properties and the distance of the property lines from block corners or from each other will not be plotted.

RECTANGULAR INTERSECTION CARDS—The upper edge of the highway intersection cards will be north; not true north, but the north used when plotting the streets between the intersections.

A Tar Macadam Pavement was laid on Margate Pier, London, England, as far back as 1820, or very shortly after the introduction of gas lighting. More than that, it was constructed by the "penetration method." This method of treatment was recommended for macadam roads by a correspondent of the "Mechanics' Magazine" in 1824.

HIGHWAY BLOCK RECORD

HIGHWAY FROM TO

PAVING: SURFACE BASE UNIT COST: SURFACE BASE

PAVED BY ADDRESS

FINISHED GUARANTEE PERIOD YEARS. EXPIRES

MAINTENANCE DATA

YEAR	YARDAGE REPAVED	TOTAL COST	UNIT COST	UNIT COST PER YEAR PER SQ. YD. OF PAVEMENT	YARDAGE REPAIRED OVER CUTS	REMARKS

FIG. 3. PAVEMENT MAINTENANCE RECORD CARD, PHILADELPHIA BUREAU OF HIGHWAYS; ACTUAL SIZE 8x5 IN.

Soil Loading Test for Foundation Design, Michigan Central Detroit Terminal

Difficult foundation conditions at the site of the Michigan Central Terminal, Detroit, in dense blue clay subsoil 100 ft. deep, led to extensive tests of piles and of direct soil footings. On the results of these tests was based the design of the remarkable reinforced-concrete mat footing already described*. While the tests were made 2½ years ago, their results have not been published. The

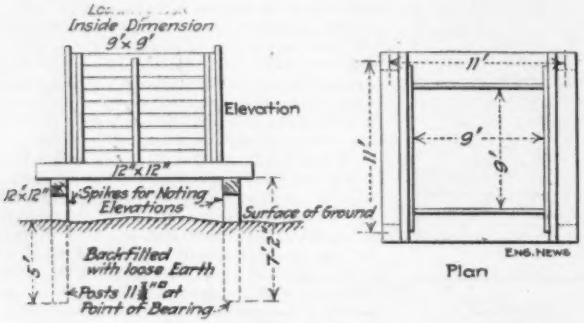


FIG. 1. TEST AND LOADING ARRANGEMENT FOR FOUR-POST SOIL TEST

following summary of the methods and results is abstracted from a copy of the official record.

FOUR-POST BOX TEST

Four vertical 12x12-in. posts, Fig. 1, were set in holes or narrow pits about 5 ft. deep, arranged in a square 11 ft. on a side. On the posts was built a platform supporting a square box. *The pits were backfilled with loose earth around the posts;* this evidently tended to maintain the original soil surcharge at the level of post bottom, and acted to prevent any direct squeezing out of the soil under the loading posts, such as might occur if there were a free surface nearby.

For the loading, the bin or box was filled with sand, carefully dumping the sand in the middle of the box and distributing it evenly to keep the load symmetrical. The posts were a little scant of 12 in. on a side, but the units of loading were adjusted to give integral values of load per square foot of bearing area.

COLD-WEATHER SETTLEMENT—Loading was begun Nov. 14, 1911, and continued until Jan. 25, 1912. Levels were taken daily to determine the settlements. The highest loading was 4 tons per sq.ft., which was reached Nov. 28, and remained unchanged from that date to the end of the test, two months.

The settlement of the posts during the period of increasing load was quite regular. Also during the following month, December, practically no movement took place under the 4-ton loading. But beginning with Jan. 2, 1912, in a time of zero weather, settlement recommenced and continued with no letup, at a very uniform rate, until the end of the test period. The settlement during these three weeks was somewhat greater than the total settlement up to Jan. 2. The final settlement averaged 0.088 ft. for the two northerly posts, and 0.052 ft. for the other two.

Evidently the load of 4 tons per sq.ft. exceeded the bearing power of the soil under particular conditions of moisture and temperature, or under variable conditions.

SINGLE-POST PLATFORM TEST

A second test, using a single-post platform, was carried to only two-thirds as high a loading, namely, 5500 lb. per sq.ft. Its special purpose was to verify the observations under low loadings. The post, 12x12 in., was set in a pit 5 ft. deep, backfilled with loose, dry dirt. Load was applied by I-beams and pieces of rail laid on top of the post, 2 ft. above ground level. Loading began Nov. 15, 1911, and the full load of 5500 lb. per sq.ft. was reached Dec. 15. The settlements were normal until after Jan. 2, 1912, at which time the settlement was about 0.02 ft. On Jan. 3, more rapid settlement began, and by Jan. 25, the end of the test period, the settlement had increased by 50%, to a total of 0.030 ft.

SILL TEST IN WELL

A third test was made in a well 19 ft. deep, on a bearing plate 2x2 ft., giving 4 sq.ft. bearing area. The well was *not backfilled.* The well and the arrangement for getting a measurement of the depression are sketched in Fig. 3. The load was run up to a maximum value of 6000 lb. per sq.ft. The test was begun practically at the same time as the preceding tests, but continued much longer, until Apr. 1, 1912, or 4½ months.

The load of 6000 lb. per sq.ft. was reached by Nov. 28, and the settlements up to this time and for four days following were normal. Between Dec. 2 and 4, a sudden settlement of 0.026 ft. occurred. There was no further settlement for 26 days. But beginning on Dec. 30, new settlement was noted, and as the curve in Fig. 3 shows, it increased steadily and rapidly, with no indication that the load came to a final bearing, even up to the end of the test on Apr. 1. The final settlement was

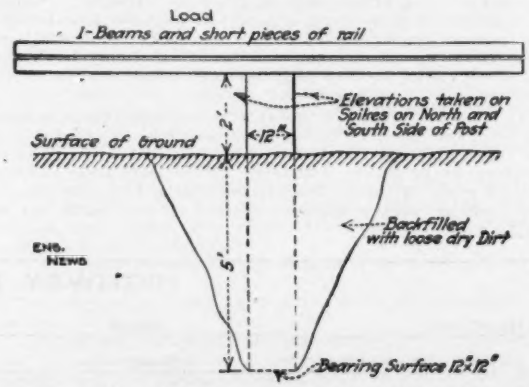


FIG. 2. SINGLE-POST TEST, FOR CHECK ON EFFECT OF LOW LOADING

over 0.300 ft., and at this time the load was beginning to tip. This stopped the test in fact, as on Apr. 2 the load tipped against the wall of the well.

An important difference between the first two tests and the third (besides the absence of backfill in the latter) is that the former were open to the weather, while the well was covered by a wooden shed, and a drain trench was built around the well about 2 ft. distant to divert the surface water. In spite of this, the general phenomena of the settlement were the same as in the other tests. Water was not kept away from the loaded area

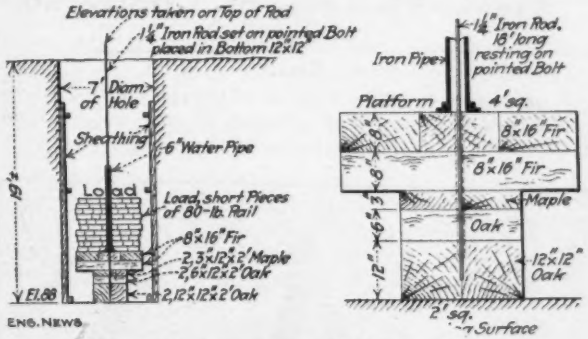
*See "Engineering News," Sept. 3, 1914, p. 502.

entirely, for at the end of the test there were 3 in. of water in the well.

The result of the test of the 2-ft. square sill in the well are shown in Fig. 3 by a curve, plotted on time as a base and settlements as downward ordinates. The temperature curve is plotted below, to show the influence of cold weather on the progress of this test.

Pier Test

A much larger bearing area and different conditions of loaded surface were tested by means of a pier test,



Test Arrangement for Sill Test

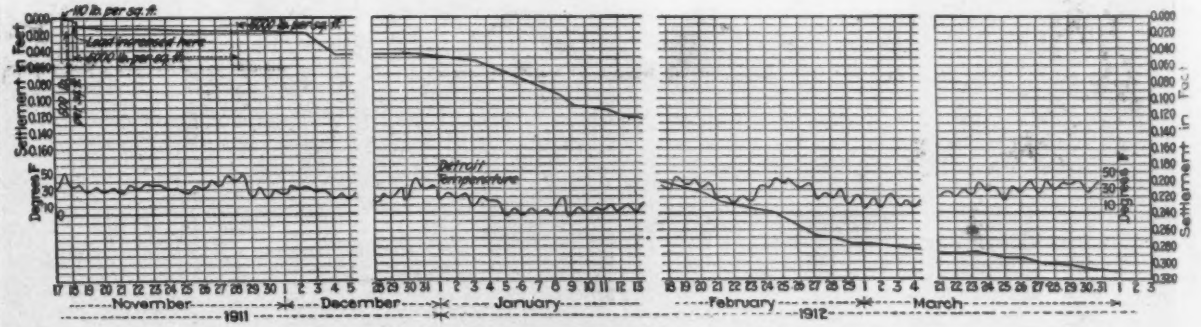
within the bearing capacity of the soil; whereas the preceding test showed that under somewhat different loading conditions a loading only 500 lb. higher exceeded the capacity of the soil and produced continuous settlement.

Use of the Data

It had been assumed in advance of the test that a load not greatly exceeding 2 tons per sq.ft. ought to be safe for the clay in question, and it was known that a satisfactory foundation could be designed within this loading. The results of the test were interpreted as confirming the belief that 2 tons per sq.ft. was safe.

Pile-Loading Tests

Simultaneous with the soil tests, test piles of various kinds were put down and loaded. In all, there were 36 such piles, comprising wooden piles and four kinds of concrete pile. At the start, it was decided that 20 tons safe loading per pile would probably justify the use of piles for the foundation. But the tests did not support the belief that 20 tons loading would be safe; on the contrary, all but two or three individual piles had what might be called their yield-point at or below 10 tons. On this showing, and the proof (by the soil-loading tests) that direct footings with 2 tons per sq.ft. would be safe, the direct footings were adopted; and, on the



Curves of Settlement and Temperature, for Sill Test

Fig. 3. Sill Test in Well

(Soil, blue clay just moist enough to be molded in the hand. Bottom of well carefully leveled. No indication of soil cracking or sliding in completed well; sheeting placed as precaution. Load, 1-ft. lengths of 80-lb. rail. Bottom of well, El. 88, Detroit datum.)

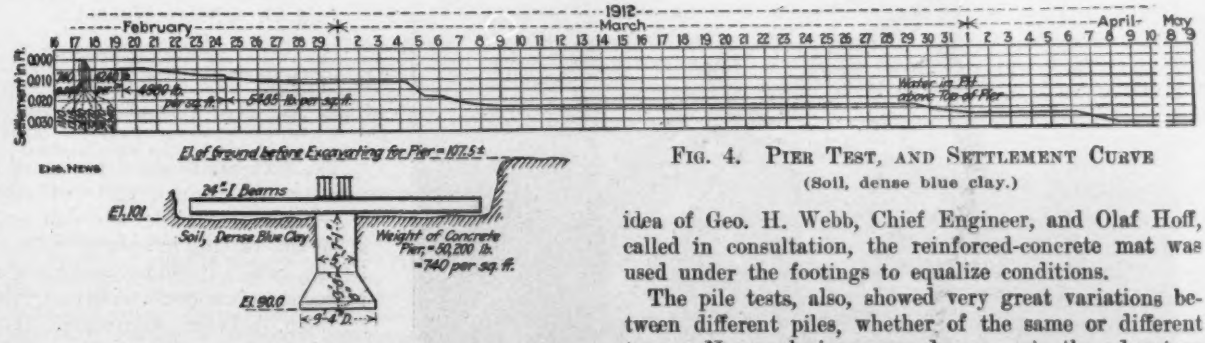


Fig. 4. Pier Test, and Settlement Curve

(Soil, dense blue clay.)

Fig. 4, begun in February, 1912, and continued until May. Here the loading was carried up to 5500 lb. per sq.ft., and while the settlement started and stopped somewhat irregularly at different times, the final result was a practically stable condition. It was concluded that this load, on a pier completely imbedded in the earth, was idea of Geo. H. Webb, Chief Engineer, and Olaf Hoff, called in consultation, the reinforced-concrete mat was used under the footings to equalize conditions.

The pile tests, also, showed very great variations between different piles, whether of the same or different types. No conclusions were drawn as to the advantage of one type over another.

Drainage Construction on United States Reclamation Service Projects to Dec. 31, 1913, had cost a total of $1,339,404 and it was estimated that by the close of 1914 the total outlay for this purpose would be about $2,500,000.

A Bridge Wrecked by a Derailed Passenger Train

A passenger train on the Baltimore & Ohio R.R. broke down a steel bridge at Woodlyn, Penn., near Philadelphia, on Saturday, Sept. 19, as was briefly noted in our last issue. This unusual accident is shown in the two views herewith, from photographs taken by the Philadelphia *Public Ledger*.

F. L. Stuart, Chief Engineer of the B. & O. System, describes the collapse of the bridge as being caused by damage to the end-post by the derailed train:

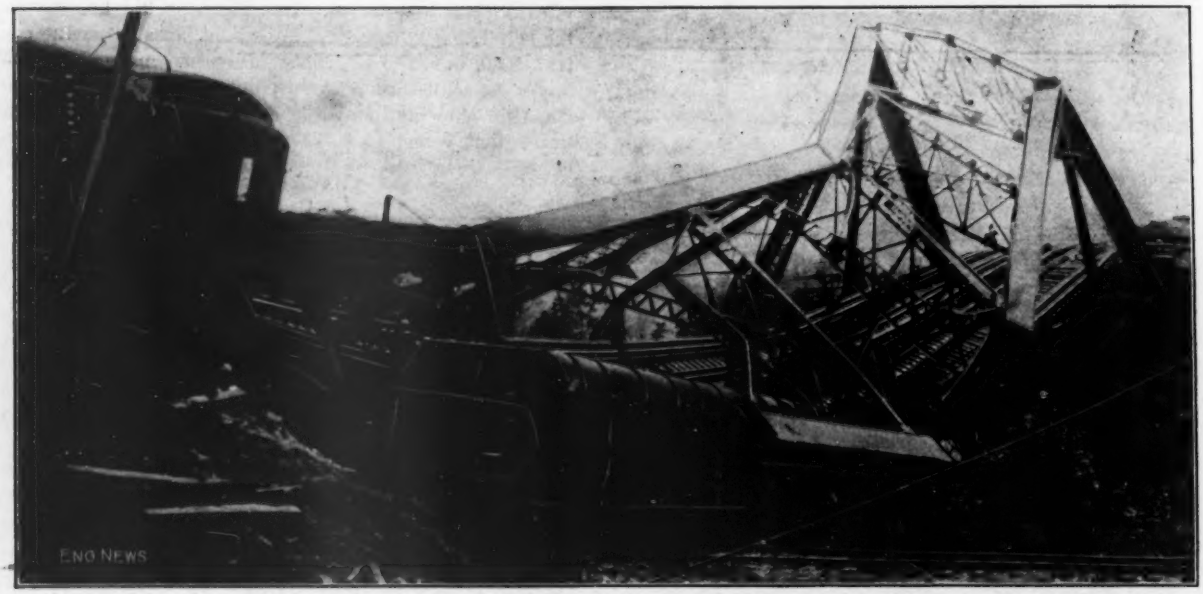
The train was westbound, and was derailed a few hundred feet east of the bridge, due to a broken axle in the forward truck of the tender on the north or right-hand side of the train. The engine and the first few cars passed over the structure, but apparently the first sleeping-car rammed the east end-post on the north truss, and damaged it to such an extent that the span collapsed in a gradual manner. After the wreck, the end-post was found broken in two.

Two of the floor-beam hangers and some of the other members in the structure were broken, but apparently the primary cause of the failure was the destruction of the end-post. There was no damage to the floor system proper which would have caused the collapse of the span.

The bridge is a double-track through span of Warren web with verticals; 163 ft. long c. to c. pins, six panels; trusses 34 ft. deep c. to c., and spaced 28½ ft. apart. The floor has four stringers, i.e., two per track 7 ft. apart. The portals are open-webbed trusswork; the remnants of the east portal may be seen indistinctly in Fig. 2.

Failure of Falsework under 12th Street Viaduct, St. Louis, Mo.

Later advices from St. Louis report that the partial failure of the 12th St. Viaduct noted on p. 661 of last week's issue, was not a collapse of the span during the removal of the forms, but a failure of some wooden falsework timbers during the laying of the concrete.



WRECK OF 163-FT. TRUSS BRIDGE BY A DERAILED TRAIN ON THE B. & O. R.R. AT WOODLYN, PENN.

(Both views are from the east end of the bridge. The right-hand or north end-post was broken, presumably by being struck by the first sleeping-car of the train.)

The 12th St. Viaduct consists of a number of deckspan units of reinforced concrete girder-and-slab construction, varying in span from 28 to 54 ft., which together make up a bridge structure 80 ft. wide and 1480 ft. long, between abutments. The west half of spans 16 and 17, each 54 ft. long, and extending between expansion joints, were poured from each end simultaneously on Sept. 17. Span 16, the north span, extended over two through tracks of the Missouri & Pacific Ry., on which there is very heavy traffic. The major por-

tion of the centering for both spans consisted of a 33-ft. span of old 24-in. 100-lb. steel I-beams, supported by 8-in. timber posts with 8x8-in. caps, and resting on grilled mud sills, the arrangement being such that two I-beams with two posts receive the weight of a concrete stringer and its slab portion. These posts were so braced that the ratio of slenderness amounted to about 15. They were intended to be proportioned for a load of from 800 to 1000 lb. per sq.in. A similar construction had been used successfully on all that part of the bridge which had already been built.

The pouring of the concrete was completed about 8 p.m., and the levels for the top of a coping along the west side of the bridge had been run, and the settlement was measured and found to be about 2 in. This coping is capped by a 3½-in. finishing surfacing, which is put on after the settlement has taken place. This was being put on at 8:20 p.m., when the centering collapsed under the west 20 ft. of the span 16—that is, the span over the railroad tracks—and the wet concrete fell to the tracks below, carrying five men, including the city's engineer and an inspector for the city, the superintendent for the contractor, and two concrete laborers. Two outside stringers, together with their slab portions, dropped the 30 ft. to the tracks below, leaving the inner three stringers and their slab portions in place. The men were more or less seriously injured, but are now recovering. The accident occurred immediately after the passage of a switching engine under the span.

The condition of the wreckage indicated that the failure of the wooden columns was probably the cardinal factor in the collapse. These posts should have been strong enough to take the loading, but some of them were spliced out of three pieces, and in addition possibly had insufficient lateral bracing. The accident may have been brought about by a variety of causes, such as the overloading of some of the posts by unequal settlement, the improper placing or fastening of slabs where some of the 8x8-in. posts were spliced, the unsymmetrical placing of the footings or sills for the posts with reference to the posts, the lack of square bearing on the spliced posts, etc.

A railway wrecking crew cleared up the débris in six hours. The cost of the accident to the contractor, including the removal of the débris and the reconstructing of the collapsed portion, will probably amount to about $2000.

⁂

A Temporary Bulkhead at Seabright—The citizens of Seabright have raised funds for the erection of a temporary bulkhead to replace in part the one demolished by the terrific ocean storms of Dec. 25-26 and Jan. 3-4. Jesse A. Howland is repairing the jetty in front of the Octagon Hotel property, and building a bulkhead 550 ft. long. Thomas J. Scully has a bill before Congress to build a breakwater at Seabright; but its passage is doubtful at the present time.

⁂

Studies of Mine Caving and Surface Support—Following the studies of mine-caving conditions and surface subsidence at Scranton, Penn., and the more general study of the mine-cave problem by the Pennsylvania State Anthracite Mine Cave Commission, further work will be done in this field by the U. S. Bureau of Mines in coöperation with the U. S. Geological Survey. Mining engineers and geologists of these two bureaus will make detailed studies of the extensive open-cut and underground mining operations of western New Mexico. Earth pressures and surface subsidence as related to geological formation and mining efficiency, and as affected by the mine equipment, will be studied. Charles Enzian, mining engineer, under the direction of Chief Mining Engineer George S. Rice, will represent the Bureau of Mines in the investigation.

Recent New York City Sewer Explosion

The accompanying views from photographs taken the morning following the sewer explosion in East 42nd St., New York City, described on p. 661 of ENGINEERING NEWS of Sept. 24, give some conception of the violence of the explosion.

Tests of the sewer air made in the same sewer subsequent to the explosion, by the Division of Combustibles of

MANHOLES ON NEW YORK SEWER AFTER EXPLOSION OF SEPT. 22

the New York City Fire Department, revealed very appreciable quantities of gasoline vapor. By search it was determined that certain garages were allowing considerable quantities of gasoline and oil to find a way into the sewer.

Notes from Engineering Schools

UNIVERSITY OF PITTSBURGH—The School of Engineering will give evening graduate courses for men who hold a B. S. degree. This has been arranged to accommodate a large number of engineers in this district who desire to undertake further study but cannot devote any of the working hours to it. Courses will be offered in the mechanical, civil and electrical fields generally; among the special subjects are mentioned sanitation, concrete construction and railway mechanical work. Prominent engineers in the district will coöperate.

OHIO STATE UNIVERSITY—A short course in industrial arts and science has been arranged for those who have been unable to take a regular technical course but who need preparation for advanced positions and added responsibilities. The studies will require two years, from about Sept. 15 to June 15. The entrance requirements are ability to read, write and compute; if an applicant is under 21 years of age, he should have had two years' practical experience in manufacturing. During the first year, the subjects covered are mathematics, drawing and shopwork; in the second year are given mathematics, drawing, mechanism, physics, materials, shopwork. Men proficient in any studies scheduled may substitute others.

A Department of Agricultural Engineering has been established. At first, instruction will largely be confined to building construction and management of machinery.

NEWS NOTES

Mt. Lassen's 48th Eruption Since May occurred on Sept. 21. Concussion from the explosion which opened a new crater, was felt at Macomber Flat, 9 mi. distant. The volcano now has four craters.

Heavy Blasts Brought down Plaster Ceilings in the Royal Victoria Hospital, Montreal, Que., recently. The hospital authorities have applied for an injunction restraining the contractors from blasting in the immediate vicinity of the institution. The work is in connection with the leveling of McGill campus. The ground was partly rock.

A Cylinder of Hydrochloric Acid Was Broken Open in the Jersey City station of the Erie R.R. and Hudson Tubes, during the rush hour, on the morning of Sept. 24. A steel-cylinder tank about 4 ft. long slipped and fell while being loaded on a car by employees of the Wells-Fargo Co., and the top of the tank was broken off. The accident occurred about 15 ft. from the stairways leading to the underground ticket office of the Hudson & Manhattan Tube Ry. The fumes were drawn into the long tunnel leading to the tracks of the Hudson Tubes. In 15 minutes, 25 persons had been overcome by the liberated gas, and many others were more or less affected.

A Break in a 48-in. Force Main at Cincinnati, Ohio, was noted in our issue of Sept. 24, 1914. At our request, J. A. Hiller, General Superintendent of Water-Works, Cincinnati, Ohio, has sent us the following note on the break:

The break was in a 48-in. pump main, wherein the pressure was about 185 lb. The break was about 4 ft. around the hub of the pipe, and extended about 10 ft. toward the spigot end. The pipe thickness was 2 in., was of even thickness throughout, and showed no flaw or defect. The main was laid in a stratified formation, and there was no settlement or movement of the pipe in any direction. The main has been subjected to the same pressure many times since its construction seven years ago. A check valve at the top of the hill closed, thus conserving the water in the tanks and in the mains above. This main was the only supply to a very large territory, and during the time repairs were being made, a large number of people were without water. The break was repaired and pumping resumed in 44 hr.

A Partial Failure of the Stark-Lyman Building in Cedar Rapids, Iowa, occurred in November last while the building was in process of construction. Full accounts of the failure were published in "Engineering News" at the time and it will be remembered that there was some controversy as to whether the failure was due to the designs on which the structure was erected or to the freezing weather that prevailed previous to the collapse, while concrete was being placed. We are informed that the building has now been completed according to the original plans. Before undertaking to reconstruct the portion of the building which failed an official test was made of the standing part of the building, which had been built before freezing weather, and the designs for the structure were submitted to several engineers to be checked over. On the approval of these engineers the reconstruction was carried out according to the original plans.

A City University for Cleveland, Ohio, is being studied by Mayor N. D. Baker and A. T. Burns under the auspices of the "Cleveland Foundation" and independently by a citizens' committee. The project contemplates the possible amalgamation of Western Reserve University, Case School of Applied Science, and the Cleveland School of Art, as well as the city health, charity, welfare and engineering departments.

The Panama-Pacific Exposition Will Not Be Postponed, on account of war conditions in Europe, according to a statement issued by the State Department, Washington, D. C., on Sept. 24. The announcement is as follows:

The Exposition will open on Feb. 20, 1915. The Government has received official notice from 37 foreign governments of their intention to participate in the exposition, and no foreign nation has given notice of its intention to withdraw on account of the war. In addition to the official acceptance, the Exposition received assurances from committees in four nations that the people of those nations would participate. Among these committees were two formed in Great Britain and Germany. Neither of those nations had given notice of governmental participation. The governments of France and Italy have given notice that they will proceed with their plans for participation, notwithstanding the disturbed condition in Europe.

The Records for Placing Concrete Masonry in Kensico Dam as noted in "Engineering News," June 4 and July 30, 1914, were again surpassed in August, when the total amount of masonry of all kinds placed in the dam was 84,450 cu.yd.; of this 1310 cu.yd. was placed by a second shift—deducting this the record for the month on a one-shift basis is as follows:

Number of working days (8 hr.)	26½ days
Total masonry placed in dam, all kinds	83140 cu.yd.
Average amount of masonry per day	3137 cu.yd.
Best day's work	3572 cu.yd.

The dam is now completed to Elev. 330 in one section, 314 in eight sections and 286 in seven sections. The top of the dam is Elev. 370. Seventy-six per cent. of the masonry is now completed.

This month's work will probably stand as the record on this structure, as the cross-section of the dam in the upper portions is so much smaller than below that it will not be possible to maintain the recent rate of progress.

During the five months, April to August, inclusive, 348,830 cu.yd. of masonry were placed in 128 working days, or a daily average of 2725 cu.yd.

An Exhibition of Street-Cleaning Appliances will be held in New York City, from Nov. 23 to 28, by the Department of Street Cleaning of New York City, according to a notice just sent out to manufacturers by Commissioner J. T. Fetherston (Municipal Building, Borough of Manhattan, New York City). The exhibit will be at Department Stable "A," 17th St. and Ave. C, Borough of Manhattan. Manufacturers and others are invited to show either working apparatus or models, illustrations of various sorts or other material. It is hoped that the exhibition will attract manufacturers and inventors from all over the country. Commissioner Fetherston's statement regarding the purpose, nature and object of the exhibit is as follows:

The purpose of this exhibition is threefold: (1) To show the people of the City of New York the types of equipment now in service. (2) To give manufacturers of modern street-cleaning apparatus an opportunity of exhibiting their various appliances, not only to the citizens of New York, but also to officials of surrounding communities who will be invited to attend. (3) To provide an opportunity for practical tests or demonstrations of street-cleaning appliances under such conditions as will be acceptable to the city and manufacturers.

The street-cleaning apparatus proposed for exhibition will cover all sorts of brooms, brushes, sweeping machines, flushing machines and other equipment or appliances used in cleaning streets and removing snow; garbage, ash and rubbish cans or receptacles used by householders; carts, wagons, motor trucks or other vehicles used for collecting garbage, ashes, rubbish and street sweepings; conveyances for transporting refuse by water or by rail; methods used for the disposal of garbage, ashes, rubbish and street sweepings, including garbage-reduction works, garbage crematories, incinerators, destructors, etc.

The City of New York is considering the adoption of improved methods and appliances for street cleaning, refuse storage, refuse collection and refuse disposal. An appropriation amounting to $250,000 has been made for the purchase of apparatus to be installed in a "Model District" of the Borough of Manhattan. The object of the exhibit will be to give every manufacturer or inventor an opportunity of bringing to the attention of the city officials their various appliances, likewise providing a chance for examining and testing these appliances during the period while the exhibit is being held. The city cannot guarantee expenses nor sales of apparatus, nor can it assume any responsibility further than the care of the equipment while stored at the city stable. All expenses and risks in connection with the exhibit must be borne by the exhibitors.

PERSONALS

Mr. S. L. Schoonmaker, of New York City, has been elected Chairman of the Board of Directors of the American Locomotive Co.

Mr. W. H. Seward has been appointed Assistant Engineer of the Chicago, Burlington & Quincy R.R., with office at St. Joseph, Mo., succeeding Mr. E. H. Peck.

Mr. J. A. Dice, of Warsaw, Mo., has been appointed County Surveyor and ex-officio County Highway Engineer of Benton County, Mo., succeeding Mr. J. M. Moss, who has resigned to engage in the lumber business.

Mr. Alfred C. Taddey, recently Architectural Engineer, Department of Buildings, Milwaukee, Wis., has been appointed Engineer of Construction of the new State Correction House Buildings at North Milwaukee, Wis.

Mr. M. E. Wells, Engineer with the Michigan Railroad Commission, has been appointed Senior Inspector of Motive Power, Division of Valuation, Interstate Commerce Commission, Southern district, with headquarters at Chattanooga, Tenn.

Mr. Thomas F. Dwyer, a public school teacher of Long Island City, N. Y., has been appointed Deputy Commissioner

of the Department of Water Supply, Gas and Electricity, for the Borough of Queens, New York City, at a salary of $4000 per annum.

Mr. Andrew W. Woodman, M. Am. Soc. C. E., Consulting Engineer, of Chicago, Ill., has been elected President of the Joliet Bridge & Iron Works, Joliet, Ill. Mr. Raymond Morrison has been elected Vice-President and Mr. Ernest Rollinson, Secretary.

Maj. C. O. Sherrill, Corps of Engineers, U. S. A., has been relieved of duty as Engineer in Charge of the Fourth District of the Mississippi River and the New Orleans Harbor improvement and will sail on Nov. 5 to take charge of fortification construction at Manila, P. I.

Mr. Augustus Griffin, Assoc. M. Am. Soc. C. E., Superintendent of Irrigation, U. S. Reclamation Service, Truckee-Carson Project, Fallon, Nev., has resigned to accept the position of Chief Engineer and Superintendent of the South San Joaquin Irrigation District, with offices at Manteca, Calif.

Mr. Alfred C. Callen, recently Assistant Manager and Draftsman of the Pottstown Machine Co., Pottstown, Penn., has been appointed Instructor in mining engineering at the University of Illinois. Mr. Callen is a graduate of Lehigh University, class of 1909, and was an Instructor there until 1911.

Mr. A. H. Ayers, Assoc. M. Am. Soc. C. E., Superintendent of Construction, U. S. Reclamation Service, Great Falls, Mont., has been promoted to be Engineer on the Sun River Project at Fort Shaw, Mont. Mr. Ayers was formerly Division Engineer of the irrigation project of the Southern Alberta Land Co., Alberta, Canada.

Mr. Frank M. Patterson, for 27 years with the engineering department of the Chicago, Burlington & Quincy R.R., has been appointed Field Engineer, Division of Valuation, Interstate Commerce Commission, Central district, with headquarters at Chicago, Ill. He was recently Engineer of the Missouri district of the C. B. & Q. R.R.

Mr. John Williams Davis, Assoc. Am. Inst. E. E., has been appointed Instructor in electrical engineering at the University of Illinois. Mr. Davis is a graduate in mechanical engineering of Cornell University, class of 1910, and has been an instructor in electrical engineering at Vanderbilt University and Leland Stanford, Jr., University.

Mr. F. R. Schanck, for several years in charge of the mechanical and engineering parts of the power and irrigation work on Indian Reservations for the United States Indian Service, has been promoted to be Assistant Chief Engineer of the Indian Service. He will have charge of the same branches of engineering, but his headquarters have been moved from Los Angeles, Calif., to Washington, D. C.

Mr. Horatio S. McDewell, Jr. Am. Soc. M. E., for the past year Assistant to Prof. L. S. Marks, of Harvard University, in his work as Editor-in-Chief of a new Mechanical Engineers' Handbook, has been appointed Instructor in mechanical engineering at the University of Illinois. Mr. McDewell is a mechanical engineering graduate of Harvard University, class of 1907. From 1908 to 1913 he was with the Allis-Chalmers Co., Milwaukee, Wis., first as an apprentice, and finally as Gas Engine Erecting Engineer.

Mr. F. L. Stuart, M. Am. Soc. C. E., Chief Engineer of the Baltimore & Ohio R.R., has been appointed by Mayor John Purroy Mitchel of New York City, a member of the advisory committee on port development at New York. Messrs. Ralph Peters, President of the Long Island R.R. and P. J. Flynn, Vice-President of the Delaware, Lackawanna & Western R. R., have also been named as members of the committee. The New York City Department of Docks and Ferries intends to work out a comprehensive plan for enlarging the shipping facilities of the harbor, and the coöperation of the large railway systems is sought.

Mr. Charles A. Ellis, Assoc. M. Am. Soc. C. E., former Resident Engineer, Dominion Bridge Co., Winnipeg, Man., has been appointed Assistant Professor of civil engineering at the University of Illinois. Prof. Ellis graduated from Wesleyan University, Middletown, Conn., in 1900. For a year he was Assistant City Engineer of Middletown, and for seven years Structural Engineer with the American Bridge Co. at Berlin, Conn., New York City and Ambridge, Penn. He was Assistant Professor of structural engineering at the University of Michigan from 1907 to 1912, and since then has been with the Dominion Bridge Co. of Canada.

Mr. H. C. Grant, former Superintendent of the Canadian Pacific Ry. at Brownville Jc., Maine, and recently Assistant General Superintendent of the Atlantic division at St. Johns, N. S., has been promoted to be General Superintendent of the Atlantic division, succeeding Mr. William Downie, who has retired after a service with Canadian Pacific Ry. extending over 27 years. Mr. Grout is a graduate of the engineering staff of the railway. He was in the construction and maintenance-of-way departments from 1898 to 1910, rising from the position of Rodman to that of Assistant Division Engineer at Toronto, Ont. Since 1910 he has been in the operating department.

Mr. Edwin Frank, Jr. Am. Soc. M. E., recently a draftsman in the centrifugal pump department of the Allis-Chalmers Co., Milwaukee, Wis., has been appointed Instructor in mechanical engineering at the University of Illinois. He graduated in mechanical engineering at the Massachusetts Institute of Technology in 1906, served a two years' apprenticeship with the Allis-Chalmers Co., Milwaukee, Wis., and then spent two years in Germany, where he was Draftsman and Engineer in the centrifugal, pump and steam departments of the Maffei-Schwartskopff Werke, of Berlin, at the same time attending the Konigliche Technische Hochschule zu Aachen. Since 1911 he has been with the centrifugal pump department of the Allis-Chalmers Co.

The Department of Architecture of the University of Illinois announces the following new appointments to the faculty: Mr. William D. Foster has been appointed Instructor in architectural design. He is a graduate of the Massachusetts Institute of Technology, class of 1911, and since June, 1913, has been Head Draftsman for Lour & Bollenbacher, Chicago, Ill. Mr. Ralph S. Fanning has been appointed Instructor in architectural design. He graduated from Cornell University in 1912 and for the past year has been a designer with F. J. Hughes & Co., Dayton, Ohio. Mr. William M. Stanton, a 1913 graduate of the University of Pennsylvania, has been appointed Instructor in architecture; and Mr. William S. Wolfe, a 1913 graduate of the University of Illinois, has been appointed Instructor in architectural engineering.

OBITUARY

Joseph F. Weekes, a retired Consulting Engineer, of Salem, Mass., died Sept. 20, aged 77 years.

John G. Haun, Supervisor of Bridges and Buildings of the Virginia & Southwestern Ry., of Bristol, Tenn., was killed, Sept. 14, when the motor car in which he was traveling was derailed in crossing a trestle.

John B. Carter, President of the Carter Construction Co. and the John B. Carter Co., New York City, died Sept. 10, at his home in that city, from nephritis. He is survived by a widow, a daughter and a son, John B. Carter, Jr. Mr. Carter was born Jan. 4, 1861, at Louisville, Ky. His father, Van Buren Carter, who was a newspaper man, died when the son was 18 months of age. His infancy was spent in Harrodsburg, Ky., where he received a common-school education. At the age of 15 years, he entered the employ of Tabler, Rosser & Co. as commissary clerk, and he remained with them several years. His next employment was with Mason, Hogue & Co., with whom he remained until he was 22 years of age, when he received a subcontract from that firm. His rise in the construction world was steady. It was a habit in his early career, which he followed to the time of his death, to remain personally upon any work which he undertook, or to be in constant touch with it. Some of his most noted achievements were the extension of the Bangor & Aroostook Ry., in Aroostook County, Maine; the construction of the Washington County R.R., along the east coast of Maine; an extensive system of government highways in Porto Rico; the construction of the Green Tree Tunnel and work for the Wabash R.R. entrance into Pittsburgh; the Indianapolis Southern R.R. from Indianapolis to Switz City, Ind.; the organization and construction of the Lake Erie & Pittsburgh Ry. from Cleveland to Ravenna, Ohio, which he sold to the New York Central and Pennsylvania systems; the Burlington extension from Herrin to Metropolis, Ill. The Western Maryland extension from Cumberland, Md., to Connellsville, Penn., will stand as an enduring monument to his genius and energy and capacity for the rapid accomplishment of gigantic undertakings, as this work involved the construction of 87 miles of very heavy work and included the removal of 6,000,000 cu.yd. of excavation, nearly all of which was rock; the construction of five tunnels and very heavy concrete masonry for bridges. The work necessitated the use of 47 steam shovels, and was completed in the record time of 15 months. Mr. Carter lived on this work, and the strain which resulted from the constant efforts to beat all previous records wrecked his health. Three weeks before his death he secured the contracts for the construction of the Mill Creek Joint District Sewer in St. Louis, at a price of $3,200,000. He left an estate in excess of $3,000,000. [Contributed by S. F. Cohen, Carter Construction Co.]

Henry Harbinson Sinclair, M. Am. Inst. E. E., whose death, on Sept. 1, was noted in these columns of Sept. 10, was a pioneer in long-distance electric power transmission. Mr. Sinclair was born in Brooklyn, N. Y., Dec. 22, 1858. He was educated in the public schools and academies of that city. When 15 years of age, he went to sea for three years, and in 1876 entered Cornell University. Later he was engaged in the shipping business for several years in New York, following which he studied law at Columbia University. During subsequent legal experience, his health failed, and he went to Redlands, Calif., in 1887, where he finally recovered. In 1896, Mr. Sinclair, as one of the organizers of the Southern California Power Co., undertook the development of power in Santa Ana Cañon, near Redlands, and its transmission to Los Angeles, a distance of 83 miles, at 33,000 volts. The voltage and distance proposed were twice as great as in any long-distance line then existing or contemplated. Foremost electrical authorities refused indorsement, and thus his undertaking was heroic, both technically and financially. However, he succeeded in obtaining capital, and work was begun. During construction, the company's property was purchased by the Edison Electric Co., of Los Angeles, and the entire system (the largest hydro-electric project of its time) was made a success, under the management of Mr. Sinclair and superintendence of Mr. O. H. Ensign, now Chief Electrical Engineer of the U. S. Reclamation Service. During this period, under Mr. Sinclair's management, the Mill Creek Plant, with 1960-ft. head, was built. This was for many years the highest head in the world. Under the active supervision of Mr. Sinclair, the Edison Electric Co. installed on its system the first oil-break switches, revolving field generators, 12,000-volt generators, high potential measuring instruments, steel towers and steam turbines ever brought west of Chicago. After the completion of the Kern River plant of the Edison Electric Co., Mr. Sinclair maintained a consulting engineering office in Los Angeles until 1909, when he went to San Francisco to assume management of the Great Western Power Co., which position he occupied for two years. During that time the company carried on the construction of two monumental dams and developed an extensive power market. After severing his connection with Great Western Power Co., although because of failing health an immediate rest seemed imperative, his many interests in Southern and Lower California necessitated his maintaining an office in Los Angeles until 1914. During this time, under his management, the industrial city of Torrance was built, this being another example of his wonderful executive ability.

ENGINEERING SOCIETIES

COMING MEETINGS

INTERNATIONAL IRRIGATION CONGRESS.
Oct. 5-9. At Calgary, Alta. Secy., Andrew Miller, Industrial Commissioner, Calgary.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 6-9. Annual meeting at Boston, Mass. Secy., Charles Carroll Brown, Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 12-16. Annual convention at Atlantic City, N. J. Secy., E. B. Burritt, 29 West 39th St., New York City.

NATIONAL COUNCIL FOR INDUSTRIAL SAFETY.
Oct. 13-15. Annual "Safety Congress," at Chicago, Ill. Secy., W. H. Cameron, Continental Bank Building, Chicago.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 20-22. Convention at Los Angeles, Calif. Secy., C. A. Lichty, 319 North Waller Ave., Chicago, Ill.

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS
Oct. 20-23. Annual convention at New Orleans. Secy., James McFall, Roanoke, Va.

AMERICAN GAS INSTITUTE.
Oct. 20-23. Annual meeting in New York. Secy., George G. Ramdell, 29 W. 39th St., New York City.

NORTHWESTERN ROAD CONGRESS.
Oct. 28-31. Congress at Milwaukee, Wis. Headquarters, 71 Sentinel Bldg., Milwaukee, Wis.

AMERICAN ROAD CONGRESS.
Nov. 9-14. Atlanta, Ga. Permanent headquarters, American Highway Association, Colorado Building, Washington, D. C.

INDUSTRIAL WELFARE AND EFFICIENCY CONFERENCE.
Nov. 16-20. Conference at Harrisburg, Penn. Secy., R. M. Pennock, Harrisburg, Penn.

NATIONAL MUNICIPAL LEAGUE.
Nov. 17-21. Annual meeting at Baltimore, Md. Secy., Clinton Rogers Woodruff, North American Building, Philadelphia, Penn.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS.
Nov. 19-20. Annual meeting at Columbus, Ohio. Secy., F. E. Sanborn, Ohio State University, Columbus, Ohio.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Nov. 30—Dec. 1. Annual meeting at New York. Secy., W. H. Ross, 154 Nassau St., New York City.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Nov. 30-Dec. 5. Annual meeting at Jacksonville, Fla. Secy., Prof. Selskar M. Gunn, Massachusetts Institute of Technology, Boston, Mass.

AMERICAN INSTITUTE OF ARCHITECTS.
Dec. 2-4. Convention at Washington, D. C. Secy., D. Knickerbacker Boyd, The Octagon, Washington, D. C.

AMERICAN MINING CONGRESS.
Dec. 7-11. Annual meeting at Phœnix, Ariz. Secy., J. F. Calbreath, Denver, Col.

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.
Dec. 9-12. Convention at Richmond, Va. Secy., C. A. Prosser, 140 W. 42d St., New York City.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Dec. 10-11. Annual meeting at New York City. Secy., D. H. Cox, 29 W. 39th St., New York City.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 28-30. Annual meeting at Madison, Wis. Secy., F. M. White, Madison, Wis.

American Institute of Architects—The 1914 convention will be held in Washington, D. C., Dec. 2-4. The Secretary is D. Knickerbacker Boyd, Washington, D. C.

American Civic Association—The annual convention will be held in Washington, D. C., Dec. 2-4. The Secretary is Richard D. Watrous, 913 Union Trust Bldg., Washington, D. C.

National Society for the Promotion of Industrial Education—The annual convention will be held at Richmond, Va., Dec. 9-12. The Secretary is C. A. Prosser, 140 West 42d St., New York City.

American Society of Refrigerating Engineers—The annual meeting will be held in the Engineering Societies' Building, New York City, Nov. 30-Dec. 1. The Secretary is W. H. Ross, 154 Nassau St., New York City.

American Association for the Advancement of Science—The next convocation-week meeting will be held in Philadelphia, Penn., Dec. 28 to Jan. 2, under the presidency of Dr. Chas. Wm. Elliott. The Secretary is L. O. Howard, Smithsonian Institution, Washington, D. C.

Society of Naval Architects and Marine Engineers—The next annual meeting of the society will be held Dec. 10-11, at the Engineering Societies' Building, New York City. The usual banquet will be held at the Waldorf-Astoria on Dec. 11. The Secretary is D. H. Cox, 29 West 39th St., New York City.

National Conservation Congress—The secretary of the National Conservation Congress states that the 6th annual convention, which was to have been held at New Orleans, Nov. 10-13, will probably be postponed on account of the war conditions generally. The Secretary is Thomas R. Shipp, Washington, D. C.

American Public Health Association—In connection with the 42d annual meeting scheduled for Nov. 30 to Dec. 5, in Jacksonville, Fla., a Southern Health Exhibition will be held. (Dr. C. E. Terry, Chairman Executive Committee, Jacksonville, Fla.). Health problems peculiar to the South will be considered both at the meeting and the exhibition.

Electric Vehicle Association of America—The program for the 5th annual convention has just been issued. Among the items listed for presentation and discussion, are the following: "Electric Fire Apparatus," Geo. F. Walker; "Design and Performance of Electric-Vehicle Motors," H. F. Baldwin; "The Electric Industrial Truck"; "European Development of the Electric Vehicle Industry," T. D. Wagoner; "The Motor Truck in Traffic Congestion," by Lieut. Wm. D. Mills. The general office of the Association is at 29 West 39th St., New York City.

American Railway Bridge and Building Association—The 24th annual convention will be held in Los Angeles, Oct. 20-22, with headquarters at the Hotel Alexandria. The following are the committees which will report and their chairmen: Ice Houses, C. E. Smith; Warnings for Overhead and Side Obstructions, E. G. Storck; Railroad Crossing Gates, Towers, etc., G. H. Jennings; Reinforced-Concrete Bridge Work, O. F. Dalstrom; Station Buildings for Passenger Service Only, M. A. Long; Mechanical Coaling Stations, A. O. Cunningham; Care of Traffic While Constructing Bridges to Eliminate Grade Crossings, G. T. Sampson; Water Supply, C. R. Knowles; Concrete Culvert Pipe and Concrete Piles, F. L. Burrell; Heating, Lighting and Ventilating Roundhouses and Shops, W. M. Cardwell; Concrete Posts, Poles and Signs, G. E. Boyd. The usual banquet will be held on Thursday evening, Oct. 22. The Secretary is C. A. Lichty, 319 N. Waller St., Chicago, Ill.